博士論文

Information Technology, Organization, and the Japanese Economy

（情報技術と組織、日本経済）

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論文の内容の要旨

論文題目　Information Technology, Organization, and the Japanese Economy

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Information technology (IT) pervasively affects modern society, from daily communication to business models and politics. The impact of the development of IT is also prominent on business organizations. The impact is not only about the internal structure of departments and divisions, but also about the relation between countries, regions, and entities in the market. For instance, offshore outsourcing of information services such as software development and call-center operations exemplify a new form of international production sharing. Another impact of information technology is cloud computing, which shows that it is possible to outsource computing capabilities, instead of outsourcing a whole business unit. The latest development of mass collaboration suggests that a significant part of production can be carried out by the collaboration of individuals rather than formal business entities. These organizational changes show the emergence of new relations between countries, organizations, and individuals, each of which needs to adjust their role in the market by adapting to the new environments and opportunities. In other words, information technology affects how people cooperate to produce value. Because changes in productive organizations include their impact on international trade and domestic industrial structures, these organizational changes could significantly impact national economy such as output, employment, and productivity.

The aim of this thesis is to assess the impact of information technology on the

economy, through structural changes in productive organizations. In particular, this thesis answers questions about how the development of IT affects organizational structure for production, and how these structural changes affect the Japanese economy, in terms of employment, productivity, and output. In this analysis, most discussions are based on a Japanese context and data from Japan, but the implications can sometimes be applied universally through comparison with prior studies.

This thesis provides an integrated view to understand the impact of changing organizational structures. For this purpose, analyses are conducted on stages based on a timeline from past to present. Additionally, future organizational forms are also explored to draw implication from such analyses. The analyses are reinforced by microeconomic analysis on organizational structures based on transaction cost economics, which provides the foundation on the firms' decision on organizational structure.

In the "past" stage in the integrated approach, the impact of offshore outsourcing of information services is analyzed. The analysis empirically assesses the impact of offshore outsourcing on Japanese employment from 2002 to 2006, specifying the partner countries to which information services are outsourced. Additionally, partner countries are related to certain business processes which are outsourced from Japan. The results on the impact on employment show that information services outsourcing affects employment in the manufacturing sector in Japan, but the impact is different depending on trading partners.

On the other hand, the effect of offshore outsourcing on productivity is also assessed following the same framework as the analysis on employment. The results show that the manufacturing sector gains positive effects from outsourcing to a wider range of countries than the service sector. In sum, the general impact of offshore outsourcing is the rise of productivity and the reduction of employment although the impact varies across

trading partners. In the “present” stage, cloud computing is analyzed based on DSGE (Dynamic Stochastic General Equilibrium) analysis. This analysis identifies multiple paths through which cloud computing affects the economy, and integrates the impact through these paths. The results suggest that cloud computing can raise output and employment if productivity growth is sufficient. However, one of the reasons for the positive relation between productivity and employment in DSGE analysis may be unconstrained demand.

The major part of the analyses in this thesis is on the “past” and the “present” stages which analyze offshore outsourcing and cloud computing. However, since the late 2000s, collaboration between individuals has attracted increasing attention. In order to draw comprehensive implications from the results of the analyses, future development of organizational structure is also discussed. In particular, the latest development of mass collaboration is discussed related to the open data movement and the shift to an information-centric economy. This discussion illustrates how the development of IT enabled not only the collaboration between organizations, but also between individuals, and mass collaboration and outsourcing partly share common grounds in terms of the development of IT and transaction costs.

The overall findings and implications in this thesis are summarized as follows. First, the analyses on organizational structure suggest that business organizations are changing from a hierarchically to vertically disintegrated structure through the development of IT, through the standardization of services and the development of communication networks. In addition, the shift to horizontal accumulation is also observed as a result of businesses pursuing an economy of scale. Secondly, analyses on offshore outsourcing and cloud computing suggest that overcoming the downward pressure on employment is the key to benefitting from IT. Analyses showed that the impact of offshore outsourcing is the rise of productivity and the reduction of employment. On the other hand,

DSGE analysis on cloud computing suggests that it is also possible to raise output and employment if the productivity growth is sufficient. However, one of the reasons for the positive relation between productivity and employment in DSGE analysis may be unconstrained demand. In this sense, to realize the benefit of IT on the economy, it is important to ensure IT contributes to the development of new products or services which create new demand.

Thirdly, there are significant differences among Asian countries as trading partners in terms of the effect of offshore outsourcing on economy. For example, outsourcing to China has a positive effect both on employment and productivity. On the other hand, outsourcing to India and ASEAN6 countries has a negative effect on manufacturing employment. These analyses on offshore outsourcing showed that there is significant diversity on the effects of the international trade of information services on the national economy depending on trading partners, even when limited to Asian countries. In this sense, considering how to realize mutually beneficial relationships with each country, instead of generalizing Asia as a trading partner is important.

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1. Introduction

1.1 Information Technology, Organization, and the Economy

Information technology (IT) pervasively affects modern society, from daily communication to business models and politics. The impact of the development of IT is also prominent on business organizations. Even looking at only the last decade, the vast proliferation of smart phones and social media are affecting business and communication around the world.

The impact of development of information technology is also prominent on business organizations. The impact is not only about the internal structure of departments and divisions, but also about the impact on the relationships between countries, regions, and entities in the market. For instance, offshore outsourcing of information services such as software development and call-center operation illustrates a new form of international production sharing. Another case is cloud computing, which shows that it is possible to outsource a computing capability, instead of outsourcing of a whole business unit. The latest development of mass collaboration suggests that a significant part of production can be carried out by the collaboration of individuals, not by formal business entities. These organizational changes show the emergence of new relations between countries, organizations, and individuals, each of which needs to adjust their role in the market for new environments and opportunities. In other words, information technology affects how people cooperate to produce value.

"Organization" includes a wide range of meanings; for example, "organization" can include social organizations such as the relation of political and economic entities, or it can include a relation between workers and incentive schemes in business firms. The term "organization" in this study generally refers to business organizations, focusing on how business processes for producing value are carried out. Specifically, it focuses on the scope of productive capabilities and the relation between those who take part in producing value.

There are prior studies on the impact of IT on organizations, but linking organizational change with macroeconomic analysis is not an easy task (Brynjolfsson and Hitt 2000). Such a difficulty, in part, arises where prior studies focus on intra-firm management issues as the major organizational topics associated with information technology. For example, Bresnahan et al. (2002) assessed the relation between IT and intra-firm management such as team-based work organization, individual decision authority, skills and education. Incorporating these elements into a macroeconomic framework is difficult because these organizational characteristics are absorbed with other elements into firm-level performance.

This dissertation focuses on the boundary and external relationship of organizations rather than focusing on intra-firm management. These boundary and external relationships typically include issues on outsourcing, and are more directly related to industrial structure and the composition of the national economy. From the perspective of prior studies on organizations and macroeconomics, this dissertation tries to link organizational structures and macroeconomics by focusing on the boundary and external relationship of productive organizations.

Because these changing relations of productive organizations include the impact on international trade and domestic industrial structure, they can significantly impact the national economy in terms of output, employment and productivity. The aim of this research is to assess the impact of IT on the economy, through the structural changes in productive organization. In particular, this research will answer questions about how the development of IT affects the organizational structure for production, and how these structural changes affect the Japanese economy, such as employment and productivity. In the course of analysis, most of the discussions are based on Japanese contexts and data, but implications are drawn occasionally for universal application through comparison with

prior studies.

The rest of this introductory chapter explains the approach needed to achieve this research goal. The approach of this dissertation is discussed through two points of view: an integrated approach and a focus on service and an information-centric economy. The following discussion on these approaches clarifies the structure of the research and the characteristics of this dissertation.

1.2 Integrated Approach

The impact of information technology on organizational structure can take various forms, such as international outsourcing of information services, adoption of cloud computing, and mass collaboration. This study tries to provide an integrated view on these multiple phenomena, based on a common analytical foundation and assessment on the impact of each type of organizational change on the economy. In particular, the integrated approach of this study is characterized by three points: analysis through dynamic change of organizational form, integration of the macro and microeconomic approach, and methodological diversity such as industry level evidence and the DSGE analysis.

Analysis through dynamic change of organizational form

This research views the development of IT as affecting the organizational structure of productive activities, and this change in organizational structure is continuously ongoing because of the ceaseless development of IT. Therefore, one of the important points in this thesis is the analysis and discussion based on these dynamically changing organizational changes.

This research covers mainly offshore outsourcing of information services and cloud computing, and also complements the argument on the effect of these two

organizational changes by discussing mass collaboration. These organizational changes are emerging consecutively along with a timeline, but also emerging as a consequence of technological development. Arthur (2009, p.110) argues that there are two patterns in invention: one which starts from a perceived need then finds a principle, and the other which starts from phenomenon and then finds a principle of use. This research mainly considers technological developments as enablers for the emergence of a certain organizational structure. However, these organizational changes are also discussed from the demand side complementarily in the final chapter.

The other important points in Arthur (2009) is that new technologies must arise by combination of existing technologies (p.19), and that accumulation of technologies leads to more accumulation (p.20). In the field of IT, available technologies are drastically increasing, which in turn serve as the building blocks of new technology, and accelerate innovation in IT field. Therefore, if organizational structure is also affected by the available technology[1], the change in organizational adjustment can be diverse and also accelerate. To understand the effect of IT on organizations and the economy, it is not sufficient to analyze only one of these organizational changes because each organizational form might be one of the representations of continuous change. Instead, it is important to identify the mechanisms by which IT affects organizational structure, and discuss how the economy is affected by the continuous change of organizations.

To provide an integrated view to understanding these changing organizational structures, analyses are conducted on stages based on a timeline which characterizes the past, present, and future of organizational change (Figure 1-1). As discussed above, these organizational changes emerge approximately along with time, but these changes also reflect the order of the emergence of technologies which enable these organizational forms

[1] Arthur (2009) argues that organizations can be also one of the technologies in a certain aspect.

to become available.

	Stages		
Dimensions	Past →	Present →	(Future) ⇢
Object of analysis	Offshore outsourcing of information services	Cloud computing	Mass collaboration
Methodology	Empirical analysis	Simulation analysis	Qualitative argument
Organizational perspective	Outsourcing of business unit	Outsourcing of business layer	Change in the scale and scope of productive entities

Figure 1-1. Stages and dimensions of analysis

In the “past” stage, offshore outsourcing of information services is set as an objective of analysis. Since the early 2000s, the development of information technology and communication networks has made various services tradable, such as software development and call-center operations. Since then, offshore outsourcing of these services has been conducted globally with a significant continuity. Given the availability of data on outsourcing transactions, this analysis is conducted based on empirical and quantitative analysis. In particular, the impacts on employment and productivity are examined. From an organizational economics perspective, offshore outsourcing is considered an organization to organization outsourcing of a certain business unit across borders.

For the “present” stage, cloud computing is set as the objective of study. Since the middle of 2000s, cloud computing has become one of the major topics among information technology architecture, but its effect on the economy is not known well.

Because empirical data on the transactions of cloud computing is not fully available, this analysis is conducted as a simulation based on DSGE (Dynamic Stochastic General Equilibrium) analysis. From an organizational perspective, cloud computing is considered the outsourcing of a common layer of business, because computing resources are used by various business units such as sales management, human resources management, and financial management.

In this dissertation, the major part of analysis is conducted on offshore outsourcing and cloud computing as previously mentioned. However, since the late 2000s, the collaboration of individuals for productive activity has attracted attention, with the emergence of open source software or online encyclopedia. One of the symbolic terms to describe this phenomenon is crowdsourcing, which is characterized by the combination of a top-down outsourcing approach and the participation of mass individuals (Brabham 2012). These collaborations are still in an initial stage of emerging phenomena and not a major component of the economy. However, if this collaboration has an economic rationality as productive organizations, it can be viewed as one of the future developments of organizational structure. As discussed in this chapter, this study views organizational change as continuously ongoing because of the ceaseless development of IT. In order to draw implications from the results of the analyses, it would be worthwhile to explore the future development of organizational structure.

Therefore, the future development of organizational structure is also discussed. Particularly, the latest development of mass collaboration is discussed in relation to the 'open data movement' and the shift to an information-centric economy. This thesis also argues for economic rationality of mass collaboration and its relation to outsourcings. The overall implication of this research is drawn based on the analysis on offshore outsourcing and cloud computing, taking into account the argument on future organizational

development.

Integration of macro and microeconomic approach

The ultimate goal of this study is to assess the impact of information technology on the economy on a macroeconomic scale. However, the study is also based on the microeconomic foundations of an entity's decisions regarding its own activities. There are various ways to make research more comprehensive by including multi-level analysis, such as including industry level and firm level analysis (e.g. Motohashi 2005, Ukai 2005). It is also possible to include quantitative analysis and case studies on specific firms, but in this research, the transaction cost economics (TCE) approach is employed to provide a microeconomic foundation on the economic rationality of multiple phenomena.

The analysis using TCE clarifies how the development of IT has affected organizational structure, in the form of offshore outsourcing of software development, business process outsourcing, and cloud computing. Additionally, the analysis on the impact of cloud computing is conducted using the DSGE (Dynamic Stochastic General Equilibrium) model. One of the main purposes of the DSGE approach is to incorporate an entity's behavior into a macroeconomics framework. Application of the DSGE approach in this study is also one of the expressions of macro and microeconomic integration. Rather than directly assessing the relations between macroeconomic variables, the microeconomic foundation in this dissertation makes it possible to draw more in-depth findings and discussions on the impact of IT on the economy.

Methodological diversity

As introduced in this section, this dissertation covers several topics, from offshore outsourcing, cloud computing, to mass collaboration. The most appropriate methodologies are employed in each analysis based on the objective of analysis and the available

resources. For example, analysis on offshore outsourcing is based on regression analysis based on industry-level panel data. In addition, analysis on cloud computing is conducted as a simulation based on DSGE analysis. Mass collaboration is discussed qualitatively based on transaction cost economics and the description of the latest development practices of mass collaboration and open data.

Using various methodologies, analyses on each topic fill in missing points on prior studies in each field, which are clarified in Chapter 2. Additionally, analyses on each topic complement each other because the scope and the depth of analysis differ depending on the object of analysis and methodologies. This diversity of methodology plays an important role in drawing integrated implications from findings and in discussing the current academic frontier, as well as in the challenges for economic analysis on the information economy. These implications and challenges are discussed in the final chapter.

1.3 Focus on a Service and Information-centric Economy

This study is based on a viewpoint that focuses on the shift towards service and an information-centric economy. In terms of the scope of analysis, this study focuses on the impact of organizational change for specifically providing “information services”. It is because information services are becoming an important component of economy, and also because organizations for providing information services are most affected by the development of information technology. The impact of organizational change for providing information services on the economy are assessed by dividing the effects of the impact to the manufacturing and service sector in Chapters 4 and 5, while Chapter 6 assesses the impact of organizational change on the entire economy.

Information services have characteristics such as “information” and “services”, both of which have unique characteristics and importance when analyzing the modern

economy. The service sector is increasingly becoming a major component in the economy, and the service sector has unique characteristics such as heterogeneity and proximity with customers. As the economy becomes more composed of the service sector, the decision on the boundary of firms and trade is affected by these characteristics as services. This relation of service attributes and organizational structure is discussed in Chapter 3 in detail.

On the other hand, “information” also has a unique characteristic as an object of trade. While Benkler (2006) suggests that economy is more centered on information production, Noguchi (1974) discusses the characteristics of information as economic goods, such as the cost for copy and the value of information. These points on the characteristics of information are discussed in detail in the final chapter.

This research is based on integrated analysis from past and present to the future, and the focus on the shift to service and an information-centric economy. These approaches clarify how information technology not only affects the boundaries of firms, but also affects how value is created through the relationship of entities.

1.4 Structure of the Dissertation

This dissertation is constructed as follows. Chapter 2, the literature review, introduces prior studies for the analyses in this dissertation. Specifically, Chapter 2 assesses how prior studies handled information technology and organizational issues in the studies on economy in terms both of the general framework and of specific topics. In general, most prior studies provide snapshots of limited phenomena on the impact of information technology on the economy. However, the analysis based on the overarching framework on dynamically changing practice of IT and organizational structure is missing. Additionally, it also suggests that prior studies on specific topics are also in initial stage, and there are a lot of missing points.

Chapter 3 discusses the microeconomic framework on organizational structure, which constitutes the foundation of the following analyses. This chapter analyzes the mechanisms behind a firm's decision on the outsourcing of information services, using transaction cost economics and service attributes. The discussion shows how the development of information technology affects organizational structure, and the difference of a firms' decisions on several objective services, such as software development, business process outsourcing, and cloud computing. Based on this foundation of a firms' decisions on organizational structure, analyses on economic impact are discussed along with the dynamic change of the development of IT and organizational structure.

Chapters 4 and 5 discuss the "past" stage, the impact of offshore outsourcing of information services, which is assessed empirically based on the regression analysis on industry-level panel data. The analysis specifies the partner countries of offshore outsourcing and outsourced business processes, assessing the impact on employment in Chapter 4, and the impact on productivity in Chapter 5. These analyses discuss the impact based on the results of empirical analyses and the mechanisms for the decision on organizational structure which is discussed in Chapter 3.

In the "present" stage, cloud computing is analyzed in Chapter 6 based on DSGE analysis, which is a simulation analysis on macroeconomic variables when the economy encounters the diffusion of cloud computing. Whereas empirical analysis on the past stage directly assesses the relation between the amount of offshore outsourcing and employment or productivity, the DSGE analyses on the present stage is based on the mathematical models which define microeconomic entities such as firms and households, and assesses the impact on comprehensive variables in macroeconomic scale. This analysis identifies multiple paths through which cloud computing affects the economy, and integrates the impact through these paths. The discussion on the implication is also based on the

perception on organizational structure in Chapter 3.

Before drawing implications from preceding chapters, mass collaboration is discussed in the final chapter based on the description of the latest practice and qualitative arguments. Chapter 7 describes the latest movement of open data, which is stimulating the emergence of mass collaboration. Economic rationality of mass collaboration is also discussed in this chapter, because the mechanisms behind the emergence of mass collaboration are beyond the initial scope of analysis on organizational structure in Chapter 3. In this sense, the discussion on economic rationality on mass collaboration is an extension of the initial discussion on organizational structure in Chapter 3. The discussion will show that the development of information technology, combined with the shift to service and information-centric economy, affects not only the relations of business organizations, but also the scale and scope of entities for production and the relation between them.

After the discussion on mass collaboration in Chapter 7, overall findings and implications are summarized through three points. First, the analyses on organizational structure suggest that business organizations are changing from a hierarchy to a vertically disintegrated form through the standardization of services and the development of communication networks. In addition, the shift to horizontal accumulation is also observed as seeking the scale economy. Secondly, results of analyses suggest that the impact of offshore outsourcing on the economy through organizational change is generally the rise of productivity and the reduction of employment. Cloud computing could raise output and employment if productivity growth is sufficient, but it is only feasible when demand is not constrained. Therefore, overcoming the downward pressure on employment is the key to benefit from information technology, and demand creation is important for the solution. Thirdly, there are significant variety among Asian countries as trading partners on the

effect of offshore outsourcing on the economy. Therefore, it is important to consider how to realize mutually beneficial relationships with each country, instead of generalizing Asia as a trading partner. Chapter 7 also discusses the limits, academic contribution, and future challenges of this dissertation.

2. Prior Studies

This chapter reviews prior studies which cover the topics of this dissertation. A wide range of prior studies are related to this dissertation, therefore, the structure of prior studies is presented first. Based on the structure, prior studies are discussed on the categories such as IT and productivity or firm value, IT and organizations, offshore outsourcing, and cloud computing. It is also discussed that where this dissertation is going to address among prior studies.

The Review of prior studies reveals that most prior studies provide the snapshots on the limited phenomena on the impact of information technology on the economy, but the analyses from the viewpoint of the dynamically changing IT and organization is insufficient. Additionally, it also suggests that prior studies on the specific topics are also in initial stage, and there are a lot of missing points.

2.1 Structure of Prior Studies

The structure of major prior studies is presented in Table 2-1 and 2-2 with the chapters of this dissertation. Studies in Table 2-1 are those which assess the direct impact of information technology on economic performance and organizations. Most of these studies assess the impact of IT on productivity, and some studies assess the impact on firm value and employment. Studies in Table 2-2 assess the impact of information technology through organizational changes, such as the form of offshore outsourcing or cloud computing. These studies are categorized by locations, such as the U.S. and Europe, and Asia. The remaining of this chapter introduces and discusses the prior studies based on these structures.

Table 2-1. Major studies on IT, economic performance, and organizations

Topics	Studies
IT and economic performances	Solow (1987), Brynjolfsson (1993), Oliner and Sichel (1994), Brynjolfsson and Hitt (1996), Jorgenson and Stiroh (1999), Siegel (1997), Oliner and Sichel (2000), Jorgenson et al. (2011), Jorgenson and Motohashi (2003), Motohashi (2005), Matsudaira (1997), Takemura (2003), Minetaki and Nishimura (2010), Ukai and Watanabe (2001), Ukai and Takemura (2001)
IT and organizations	Hitt (1999), Brynjolfsson et al. (1994), Hitt and Brynjolfsson (1997), Coase (1937), Williamson (1975), Dibbern et al. (2008), Ang and Straub (1998), Bahli and Rivard (2003), Blair et al. (2011), Bresnahan et al. (2002), Keizai-kikakucho (2000) Chapter 3 of this dissertation

Table 2-2. Major studies on the economic impact through organizational change

Topics	The U.S. and Europe	Asia	
		Japan	Estimation with Asian variety
Offshore outsourcing	Liu and Trefler (2008), Amiti and Wei (2005, 2009), Falk and Wolfmayr (2007)	Chapter 4 and 5 of this dissertation	
Cloud computing	Etro (2009, 2011)	Chapter 6 of this dissertation Tamegawa et al. (2014), Ukai (2013), Ukai and Inagaki (2014)	

2.2 IT and Economic Performance

Since the surging development and proliferation of information technology, their impacts have raised a wide range of public concerns. At the early development of information technology and the Internet in1980s, positive expectation as an opportunity for economic

growth has been characterized by the term of “new economy”. These expectations are realized as a number of startups which resulted in a large number of businesses in software, networks, and information services.

From economic viewpoint, the central topic on the development of information technology is whether the utilization of IT can contribute to the rise of productivity. Watanabe and Ukai (2003), which provide an overarching review on literatures which have studied the economic and business impact of information technology, suggest that a target of the academic discussion in the 1980s was the relation between IT and productivity. Motohashi (2005) also suggests that the effect on productivity is the central topic of “new economy” in the U.S.

Major prior studies which assess the direct impact of IT on economic performances including productivity and firm value are shown in Table 2-2. In terms of the studies on the impact on productivity, “productivity paradox” has been reported in the late 1980s to note that information technology investment does not raise productivity (Solow 1987, Brynjolfsson 1993, Oliner and Sichel 1994). However, the positive effect of IT on growth has been gradually reported since the late 1990s, such as Brynjolfsson and Hitt (1996), Jorgenson and Stiroh (1999), Siegel (1997), Oliner and Sichel (2000). Additionally, continuous positive effect on productivity in the 2000s is reported by Jorgenson et al. (2011). In terms of the Japanese economy, Jorgenson and Motohashi (2003) show that the growth of TFP was 1.13% from 1995 to 2000 including the contribution of IT investment. Specific effect of information technology is assessed by Motohashi (2005) which shows that Japanese firms which utilize information network mostly achieves higher TFP growth than those without information network during 1991 to 2000. Positive results are also reported by various articles, although its significance and the size of the impact are diverse across empirical settings and analyzed industrial sectors (e.g. Matsudaira 1997, Takemura

2003). Minetaki and Nishimura (2010) provide analyses on the impact of information technology on the Japanese economy from various aspects such as labor and productivity. Their analyses include the relation between outsourcing and productivity in Japanese information services industry in firm level in 1990s, although their analysis does not focus on outsourcing to overseas.

On the other hand, there are studies which assess the impact on firm value in financial market. Ukai and Watanabe (2001) showed that both of hardware and software stock led to higher firm value in Japanese banking firms in the late 1990s, and Ukai and Takemura (2001) showed that only software stocks also contributed to higher firm value during 1993 to 1999 for the same industry.

2.3 IT and Organizations

There are also prior studies which discuss the relation between the utilization of information technology and organizations as seen in Table 2-1. Among them, there are several studies which assess the impact of IT on organizations quantitatively in the firm level. For example, Hitt (1999) assessed the relations between IT capital and the boundary of firms by firm-level panel data analysis, and found that more IT capital is associated with vertical disintegration and more diversification. Brynjolfsson et al. (1994) examined the relation between IT capital and the firm size, and found that more IT capital is associated to the decrease in the firm size. Hitt and Brynjolfsson (1997) assessed the relations between IT capital and internal organization of firms. They found that more IT capital is associated to organizations with decentralized authority.

However, relating these organizational changes with macroeconomic variables is not sufficient. Brynjolfsson and Hitt (2000) suggest that there are substantial amount of literatures on the impact of IT on organizations, outputs and productivity in firm level.

However, they state that these effects are “not well captured by traditional macroeconomic measurement approaches” and one of the reasons is that it needs assumptions to “incorporate complementary organizational factors into a growth accounting framework” (Brynjolfsson and Hitt 2000, 25).

One of the difficulties of linking organizational issues with macroeconomic variables arises where there are too many aspects by the term “organization” even limiting the scope to business organizations. For example, Bresnahan et al. (2002) assessed the relation between IT and the elements such as team-based work organization, individual decision authority, skills and education. Their study was referred by other studies including Keizai-kikakucho (2000), which studied the similar research on Japan. Keizai-kikakucho (2000) focuses on the decentralization of organization, such as self-management team, flat management, teamwork in promotion. Black and Lynch (2004) do not specifically assess the relation between IT and organizations, but they suggest that workplace innovation such as incentive scheme for employee is one of the contributors for increasing productivity in new economy. These studies focus on the intra-firm aspects such as the capability of workers and the relationship between them. However, it could be difficult to incorporate these elements into a macroeconomic framework (Brynjolfsson and Hitt 2000), because these organizational characteristics are absorbed with other elements into firm-level performance.

On the other hand, this dissertation focuses on the boundary and external relationship of productive capabilities rather than the intra-firm management. These boundary and external relationship, typically issues on outsourcing, are more directly related to industrial structure and composition of the national economy. From the perspective of prior studies on organizations and macroeconomics, this dissertation tries to link organizational structures and macroeconomic analysis by focusing on the boundary

and external relationship of productive organizations.

The boundary of firms has been discussed mainly from organizational economics view, particularly based on transaction cost economics (TCE). TCE theorizes the boundary and the structure of firms (Coase 1937, Williamson 1975). Particularly for the decision on outsourcing, TCE is referred as a starting point in various articles such as Willcocks and Lacity (1995), Ono and Stango (2005) and Michael and Michael (2011). Several articles for practitioners also refer to TCE that would affect the success of outsourcing projects. (Kennedy and Sharma 2009, Manning 2006). The detailed discussion on the contents of transaction cost economics is provided in the analysis in Chapter 3.

On the other hand, in-depth analysis of TCE regarding outsourcing of information services is not so abundant. Among these studies, Dibbern et al. (2008) identify the extra costs that arises in outsourcing projects besides the direct cost paid to vendors, and analyze the extra costs by TCE and knowledge based view of the firm. From case studies, they show that the extra costs are different across each project, because of the different conditions such as client-specific knowledge, absorptive capacity, and geographic and cultural distance.

Ang and Straub (1998) empirically analyze the determinants of the outsourcing of information systems and show that transaction costs affect outsourcing decision, but its effect is much smaller than production cost. Bahli and Rivard (2003) identify the risks concerning information services outsourcing such as lock-in, and discuss the issue from TCE and agency theory. Blair et al. (2011) focus on modularity and examined the contracts that determine the interface between vendor and buyer, although they do not focus on information services outsourcing.

These prior studies deal with TCE to estimate the true cost of outsourcing of information services. They view the outsourcing of information services as possible from

the beginning. However, how information technology enabled these services tradable is not fully discussed. In addition, there are various information services, such as software development, call-center operation, or computing services. The difference of the decision on organizational structure to conduct these various services have not specifically discussed in prior studies. These are the missing points in prior studies but essential to understand how information technology affects organizational structure for carrying out the services. Chapter 3 focuses on this point and analyzes the mechanisms behind the outsourcing decision focusing on service attributes and transaction cost economics.

2.4 Empirical Analysis on Offshore Outsourcing of Information Services[1]

This dissertation is going to assess the impact on the economy following the dynamic change from past, present, and future. In the "past" stage, the impact of offshore outsourcing of information services on the economy is empirically assessed. The prior studies which are directly related to this topic are shown in Table 2-2. However, because offshore outsourcing of information services is one of the forms of international production sharing, this topic is placed in the field of international economics, particularly, outsourcing and production sharing. Therefore, prior studies in international economics field are introduced before discussing the studies in Table 2-2.

On the theoretical studies on the production sharing, Markusen et al. (1996) argue that the similarity of countries characterizes the form of foreign direct investment, such as horizontal or vertical direct investment. Other scholars also developed the theories to explain outsourcing, such as Markusen (2005), Rodriguez-Clare (2007), Baldwin and Robert-Nicoud (2007), Mitra and Ranjan (2007).

In terms of empirical studies on production sharing, a number of analyses have

[1] This section is based on Takagi and Tanaka (2010) which is revised and reconstructed for this dissertation.

been conducted to assess the effect of outsourcing on the domestic economy. Since the 1980s, there has been increasing wage gap between skilled and unskilled labor in the U.S. (Feenstra and Hanson 1999). Outsourcing has been analyzed as a factor of this change in wage and employment. For example, Feenstra and Hanson (1997) show that relative demand of skilled labor increased both in developed and developing countries by production sharing. Feenstra and Hanson (2003) empirically assess whether technological change or trade of intermediate input has affected wage gap between skilled and unskilled labor, and concluded that both of outsourcing and expenditure on computers and other high-technology capital are important explanation of the shift towards nonproduction labor in the U.S.

However, empirical results of the impact on wage and employment have not been consistent among studies. Anderton and Brenton (1999) suggest imports from low-wage countries had the effect to reduce the wage-bill share and the relative employment of less-skilled labor in the UK. On the other hand, Arndt (1998) shows that because of the outsourcing of labor-intensive components, wage rose and industry employment and output increased. Berman et al. (1994) show the shift towards skilled labor in the U.S. was mainly caused by technological change, not by trade. Harrison and McMillan (2006) argue that the effect on employment in the U.S. differ depending on the outsourcing is horizontal or vertical production sharing. Kravis and Lipsey (1988) suggest that foreign direct investment in manufacturing and service sector has different effect on the domestic demand of skilled labor.

On the other hand, there is another approach on economic analysis on outsourcing, which is to assess the determinants of outsourcing and the choice between foreign direct investment and outsourcing. Hanson et al. (2003) examine variables that raise demand for imported inputs. Bartel et al. (2005) study the elements to promote IT-service trade, and

showed that technological changes increased outsourcing of IT-based services. Chen et al. (2008) analyze the importance of knowledge capital and its effect on the choice between FDI and outsourcing. Grossman and Helpman (2002b) also explore the effects of economic variables on the choice between FDI or outsourcing. Grossman and Helpman (2002a) examine the elements which affect the location choices of global production.

However, prior studies on information services trade or general service trade are very limited. Theoretically, Markusen (2005) discusses that important theoretical themes on offshoring are (a) vertical fragmentation of production, (b) expansion of trade at the extensive margin, (c) fragments that differ in factor intensities and countries that differ in endowments, and (d) knowledge or capital stocks of countries or firms that are complementary to skilled labor and create missing inputs for countries otherwise well suited to skill-intensive fragments. Mitra and Ranjan (2007) examine the effect of offshoring on employment theoretically, and suggested that the effect depends on the allowance of labor mobility across sectors.

There are several studies on the empirical analyses on the outsourcing of information services, as seen in Table 2-2. Among them, Liu and Trefler (2008) assess the impact of information services outsourcing to China and India on U.S. employment, while Amiti and Wei (2005) assess the UK employment and information service outsourcing, and Falk and Wolfmayr (2007) conducted similar research on the EU countries. As these three are representative works on this topic, these studies are explained in detail in this section.

Liu and Trefler (2008) deal with not only offshoring but also ‘inshoring’ from China and India, which refers to service export from U.S. to those countries. They show that offshore outsourcing increases, and inshoring reduces the chance of job switching. They argue that the inshoring effect is much larger, therefore for the economy as a whole, service trade reduces job switching. In terms of unemployment, they analyze the net effect

of inshoring and offshoring and argue that the service trade has a very small effect to reduce the time of unemployment. However, generally offshore outsourcing increases, and inshoring reduces the period of unemployment. In other words, it is inferred that developed countries need sufficient export to offset the negative effect of service outsourcing in order to maintain the current industrial structure.

Amiti and Wei (2005) estimate the effect on the UK employment separating the manufacturing and the service sector. The result is service outsourcing[2] has a positive effect on employment in manufacturing sector. On the other hand, service outsourcing has a negative effect on employment in service sector. However, the authors state that the analysis on service sector is not robust because of the inconsistent result across specifications and relatively limited number of cases.

Falk and Wolfmayr (2008) show that the import of services from both low-wage and high-wage countries has no significant effect on employment in manufacturing sector on several EU countries. Instead, they find materials import has a negative impact on employment. In service sector, service import from low-wage countries has a negative effect on employment. As the authors point out, this result is consistent with Amiti and Wei (2005) which suggests service outsourcing might have a negative effect on employment in service sector. But they suggest this effect is not significant when they focus on “business services”.

Besides these three works, Ebenstein et al. (2009) also study the effect of offshoring on the U.S. wage and employment using individual data. van Welsum and Reif (2006) empirically study the factors affecting offshoring by assessing the effect on clerical and non-clerical workers separately. On the other hand, the assessment on the effect of offshore outsourcing on productivity is more limited. Only Amiti and Wei (2009) have

[2] Amiti and Wei (2005) focus on computing and information and other business services.

directly analyzed this point and found that offshore outsourcing of services has a positive effect on total factor productivity (TFP) in the United States.

In terms of the analyses on Japan, a series of study by the author such as Takagi and Tanaka (2012b, 2012c) assess the effect of outsourcing of information services on employment and productivity in Japan. However, these studies do not specify the partner countries or outsourced business processes.

In summary, there are two missing points in prior studies in this topic. First, empirical analyses have been conducted on U.S., UK, and EU countries, but analysis on Japan is not sufficient. In order to study this topic, Japan has unique characteristics such as the economic network in East Asia, employment regulations and structures, and the multi-layer outsourcing in information technology industry. It is worth to conduct detailed assessment on Japan taking these characteristics into consideration and make comparison with other countries. Second, prior studies do not analyze the variety of the effects of information services outsourcing depending on Asian trading partners. Chapter 4 and 5 fill in these missing points by conducting the analyses on Japan.

2.5 Economic Analysis of Cloud Computing

Analysis turns to the “present” stage of organizational change, that is cloud computing. A certain amount of articles have been published on cloud computing, but the concerns and academic disciplines are scattered across literatures. For example, some studies focus on technological architecture (e.g. Cretu 2002, Endo et al. 2011), and others discuss on security and privacy issue (e.g. Anthes 2010, Qaisar and Khawaja 2012, Reddy and Reddy 2011). Some studies argue the market governance such as competition law and regulation (Durkee 2010, Strømmen-Bakhtiar and Razavi 2011).

On the other hand, analytical framework and methodology for macroeconomic

analysis have been developed drastically in the last decade. Emerging from analyzing the fluctuation of business cycle (Kydland and Prescott: 1982, Long and Plosser: 1983), macroeconomic analysis with micro-foundation has become one of the dominant schools in economic literature. However, despite that one of the major concerns of the basic RBC model has been on technological innovation, RBC and DSGE have developed focusing mainly on monetary and financial analysis. More recently, DSGE analysis started to be applied to a wider range of topics such as the effect of immigration (Mandelman and Zlate 2008), incorporation of on-the-job search (Macit, 2010), productivity and energy price (Dhawan et al. 2008).

However, the assessment of the economic impact of cloud computing is limited as seen in Table 2-2. Etro (2009, 2011) uses DSGE approach on cloud computing. These studies have focused on the cost reduction effect of cloud computing and analyzed its macroeconomic impact based on DSGE model. Underlying perception of these studies is that cloud computing turns information technology cost from fixed costs to marginal costs of production. These studies assume the following effects. First, cost reduction of IT investment lowers initial barrier of entry for new firms and foster the establishment of small and medium size enterprises (SME). Second, the increase of SME would have a positive effect on employment and GDP. Third, they also analyze the impact on public accounts arguing that public spending is lowered and tax income is increased by the diffusion of cloud computing. Etro (2009, 2011) constructed the model that is augmented with the increased number of firms, and conducted simulation on EU countries. The results show that the diffusion of cloud computing boosts GDP by 0.05% to 0.15% in short term, and 0.1% to 0.3% in medium term. The estimates on business creation and job creation are shown in Table 2-3.

Table 2-3. Macroeconomic impact of cloud computing in Etro (2009, 2011)

	Speed of diffusion	Short term	Medium term	Unit
GDP	Slow	+0.05	+0.1	Percentage points per year
	Rapid	+0.15	+0.3	
Business Creation	Slow	+73,256	+83,478	Number of firms per year
	Rapid	+378,640	+430,973	
Job Creation	Slow	+300,000	+70,000	Number of workers per year
	Rapid	+1,000,000 or more	+700,000	

Notes: Impact on GDP and business creation is taken from Etro (2009), and impact on job creation is taken from Etro (2011). *Source*: Etro (2009) and Etro (2011)

Etro (2009, 2011) draw implications for various aspects such as GDP, business creation and job creation, but the basic idea is that cloud computing lowers entry cost and promotes entrepreneurship. Its model is developed incorporating endogenous growth model, but it is not easy to expand to include other aspects because of the specialized development on entry costs. More recently, Tamegawa et al. (2014) conducted DSGE analysis on cloud computing, and found that 10 percent adoption rate of cloud computing leads to 10 percent upward shift of production function for Japanese firms.

Besides the analysis with DSGE model, Ukai (2013) analyzes the relation between the financial condition of firms and their choice of using cloud computing among public, private, and hybrid. Ukai (2013) found paradoxical results that firms with more asset use public cloud computing, whereas firms with high profit use less hybrid cloud computing. Ukai and Inagaki (2014) conducted a similar analysis on firm-level, and found that Japanese firms increase the use of private cloud computing while reducing profit.

In terms of the benefit of cloud computing, Cudanov et al. (2011) point out the flexible scalability. They argue that traditional IT investment does not meet the actual

demand of ICT because it is difficult to expect the future demand perfectly, and the investment is conducted once a certain terms, not daily basis. Because of this gap of the demand and the investment, excessive investment happens under the low demand, and opportunity loss happens under the high demand period. Culdanov et al. (2011) did not present the ways to measure the amount of these losses, but this flexibility would be one of the benefits of cloud computing.

On the impact on employment, Ross (2011) discussed the impact on ICT workers in user firms. From user firms' point of view, introduction of cloud computing is similar to outsourcing because these firms utilize the resources outside the firms. Ross (2011) argues that along with the transition from in-house operation to utilization of cloud computing, the role of ICT workers shifts from "a technical to more of a *liaison* role as they engage with external service providers".

As seen in this section, several studies provide the perspectives on the effect of cloud computing, but they rather pick up various aspects partially and far from understanding the comprehensive effect. There is also missing points in previous studies such as negative effect of reduced revenue for domestic ICT firms. For example, it is possible that Japanese firms import foreign cloud services instead of utilizing domestic services. Bayrak et al. (2011) also provide a literature survey on cloud computing and point out that the literatures on the topic are scarce.

Economic analysis of cloud computing is in the initial stage and there is a large opportunity for research. Chapter 6 constructs a model to incorporate multiple effects of cloud computing, thus provides a basis for the macroeconomic analysis of technological innovations such as cloud computing.

2.6 Conclusion

This chapter reviewed the prior studies which cover the topics of the analyses in the following chapters. A number of studies have been conducted on the impact of information technology on productivity. However, the focus of these studies is on the direct relations between IT investment and productivity, lacking the analysis on how firms utilize information technology with the change of their organizational structures. In other words, prior studies focus on the relation between input and output of the economy, but lack how IT is changing economic activities between the input and output. Additionally, most prior studies provide snapshots on the effects of various phenomena separately, but the comprehensive view is not available.

Based on the achievement and the missing points in prior studies, this research aims to assess the impact of information technology on the economy through the structural change in productive organizations. Particularly, this research answers to the questions that how the development of IT is affecting the organizational structure for production, and how these structural changes are affecting the Japanese economy, such as employment and productivity. As seen in Table 2-2, this dissertation is going to fill in the missing points in the analysis on Asia. Prior studies do not assess the variety of the effect of international trade of information services depending on trading partners, and rather generalize them as Asia or low-cost and high-cost countries. On the other hand, this dissertation assesses the variety in the outcome of trading with Asian countries.

Additionally, the literature review revealed that the prior studies on each topic are in initial stage, and there are a lot of missing points. Each of the following chapters fills in the missing points in the prior studies. For example, Chapter 3 provides the framework to analyze how the development of information technology defines organizational structures, and Chapter 6 assesses the economic impact of cloud computing by DSGE analysis. These

analyses also provide the building blocks for the overall implications which are discussed in the final chapter.

The next chapter provides the foundation for the following analyses, discussing a microeconomic framework on organizational structures. It analyzes the mechanisms behind the firm's decision on outsourcing of information services, using transaction cost economics and service attributes.

3. Information Technology and Modern Business Organization[1]

Modern business organizations have been affected by the development of information technology. Particularly, information technology is affecting organizational structure in the direction of vertical disintegration and international production sharing. For example, firms outsource information services such as software development and call-center operation, and also computing services. In order to provide a fundamental analytical framework throughout this dissertation, this chapter discusses the decision on outsourcing which is affected by information technology. Particularly, it views that the outsourcing of information services has been promoted by the drastic reduction of transaction cost, rather than simply by the difference of production cost. This chapter focuses on the service attributes that affect transaction cost of information services, and provides an analytical tool on the firm's choice on organizational structures. It discusses the outsourcing decision of firms using the tool with the examples on several types of information services.

3.1 Background

Technological change has been one of the major reasons of structural change in business organizations[2]. The change in technology has affected business operations, and the new business operation has defined new organizational structure. Milgrom and Roberts (1992) briefly summarize the point as "organizations change when their environments and the technologies they use change, and as they accumulate information and experience about what kinds of organizations work best for particular tasks".

This is also applicable to modern business environment. Drastic development of

[1] This chapter is based on Takagi and Tanaka (2013a) which is restructured and revised for the dissertation.

[2] The present paper discusses the structure of business entities, including the unit of business operations and the relations of these units within a firm, and also the relation between firms. The change in organizational structure of firms could result in organizational change of industrial structure or society as a whole, but this paper primarily focuses on the organizational structure of business entities.

information technology (IT) enabled firms to outsource various types of services to overseas. For example, a significant part of information services such as call-center operation, financial processing, and software development are now provided from overseas through communication networks. These are called “offshore outsourcing” of information services. Another case is the adaption of cloud computing. By using cloud computing, firms can use computing resources that are provided by entities outside of the firm. Cloud computing enabled firms not to build and own their individual computer resources, and instead just use and pay as they use the shared resources.

Cloud computing is “a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources” (Mell and Grance 2011). In short, cloud computing is a computing resource which can be shared and used by many users through communication networks. Cloud computing is categorized to public, private, and hybrid. Public cloud computing is shared by anonymous users globally, and private cloud computing is used by a specific organization. Hybrid combines public and private. In this chapter, cloud computing refers to public cloud computing to focus on the aspect of outsourcing of computing services unless otherwise noted. Additionally, cloud computing is occasionally called as the outsourcing of computing services throughout this dissertation.

Cloud computing provides a wide range of services depending on whether it provides ready-made services or only platforms on which customized services can be constructed. For example, SaaS (Software as a Service) provides ready-made computer services for such as e-mail, human resource management, supply chain management, and customer relationship management. For instance, *Salesforce.com* provides services such as Customer Relationship Management (CRM)[3]. On the other hand, PaaS (Platform as a

[3] Based on the description at http://www.salesforce.com/products/. Accessed July 4, 2914.

Service) provides basic platforms but end-user services have to be constructed on this platform. IaaS (Infrastructure as a Service) provides mainly the minimal set of hardware functions so that services and platforms can be added on the infrastructure. *Amazon Web Services* offers mainly platform services so that customers can create and use services on the platform[4].

Cloud computing services are penetrating in Japanese market. For example, firms which use cloud computing services increased from 21.6% in 2011 to 28.2% in 2012 (MIC 2013). The U.S. firms utilize cloud computing about 1.7 times more than Japanese firms, but the gap is becoming closer (MIC 2013). Japanese firms are also providing cloud computing services particularly in Japanese market.

Outsourcings of information services and computing services are the phenomena that are affecting modern business organization, and they have common features. For example, they are enabled by the utilization of information technology. They are outsourced globally, and they have the attributes as services. They are affecting organizational structures in the direction of vertical disintegration and international production sharing. From economic perspective, their impact on the economy could be pervasive particularly on employment and productivity, reflecting the nature of information technology as a general purpose technology.

Because of its potential impact on domestic employment and innovative capacity, empirical analyses on offshore outsourcing and cloud computing have been conducted. (Amiti and Wei 2005, 2009; Falk and Wolfmayr 2008; Liu and Trefler 2008; Takagi and Tanaka 2012a, 2014, Forthcoming). However, in order to understand the impact and to make proper prediction on the potential effect on the economy, analysis on the mechanisms behind the outsourcing of these services is essential. Particularly, insight into how

[4] Based on the description at http://aws.amazon.com/ (Accessed July 2, 2014).

information technology has enabled information services to be divided from organizations and outsourced even to overseas is important to understand modern business organization.

In addition, overarching framework to understand the effect of information technology on organizational structure has not been available. Development of information technology has been generating new business models not only offshore outsourcing of services and cloud computing, but also global internet media and commerce services. Analysis on fundamental mechanisms will help understanding on the organizational change associated to the adoption of information technology.

Taking into consideration these backgrounds, this chapter aims to clarify how the development of IT affects the structure of business organizations specifically focusing on the decision of firms on outsourcing, and to provide the overarching framework for the following analyses in this dissertation.

3.2 Theoretical Foundation

This section explains theoretical foundations for discussing the organizational structure for providing information services. Particularly, it discusses the focal points of transaction cost economics and service attributes, that will be operationalized in the following sections.

3.2.1 Transaction cost economics

Traditionally, transaction cost economics (TCE) views that the boundary of firms is determined by transaction cost. Ronald Coase views that activities are conducted within organizations when it is less costly than carrying out the transactions through market (Coase 1988). Transaction cost includes various costs to conduct transactions in market, such as finding partners, making and enforcing contracts[5]. Oliver E. Williamson developed

[5] For more detail on the contents of transaction costs, see Coase (1988) and Dahlman (1979).

the Coase's theory by introducing two important human factors behind transaction cost: opportunism and bounded rationality (Williamson 1975). Williamson showed market fails when these two human factors are combined with environmental conditions: bounded rationality with uncertainty, and opportunism with small-numbers exchange relations.

Under bounded rationality, uncertainty on the contracts motives firms to conduct the task within the organization. Williamson (1975, p.9) states that "If, in consideration of these limits, it is very costly or impossible to identify future contingencies and specify, *ex ante*, appropriate adaptations thereto, long-term contracts may be supplanted by internal organization". Therefore, if the uncertainty is reduced by the introduction of information technology, there is a greater chance for the task to be delivered by market.

On the other hand, opportunism is caused by small-numbers exchange (Williamson 1975, 48). Particularly, *Ex Ante Small Numbers* is caused because "Although a large-numbers exchange condition obtains at the outset, it is transformed during contract execution into a small-numbers exchange relation on account of (1) idiosyncratic experience associated with contract execution, and (2) failures in the human and nonhuman capital markets" (Williamson 1975, 29). Simply put, first contract winner acquire the specific asset such as the know-how and the better understanding on the contract, and this assets help the seller win the contracts onwards. Where buyer cannot switch supplier because of the specific asset that is acquired by the first contractor, *hold-up* problem arises.

Williamson (1975) suggests that such a situation can be mitigated by conducting the activity in-house, because internal audit and hierarchical order can reduce information asymmetry and opportunism. Therefore, the outsourcing decision is related to the prospects on the opportunism by small-numbers exchange. If the outsourced activity includes high asset specificity and buyer faces the risk of opportunistic behavior, the buyer would conduct the activity in-house.

It is noted that TCE focuses primarily on transaction cost, which Coase (1988, p.114) explains as "In order to carry out a market transaction it is necessary to discover who it is that one wishes to deal with, to inform people that one wishes to deal and on what terms, to conduct negotiations leading up to a bargain, to draw up the contract, to undertake the inspection needed to make sure that the terms of the contract are being observed, and so on". Therefore, it is inferred that transaction cost is externalized from production cost that means the genuine cost for producing the goods or services. TCE does not focus on the difference of this production cost, but in practice, production costs could be diverse across countries reflecting the difference of factor prices, and it is certain that this difference of production cost has been one of the incentives for firms to outsource information services. However, the difference of production cost has been obvious even before the current trend of information services outsourcing. Therefore, this chapter views that the drastic reduction of transaction cost, rather than the reduction of production cost, fosters outsourcing of information services.

3.2.2 Service economy

In marketing and management field, services are defined to have four characteristics: *intangibility*, *heterogeneity*, *simultaneous production and consumption*, and *perishability* (Zeithaml and Bitner 2003, 21). For example, haircut fulfills all four attributes. One cannot touch haircut services, the contents of haircut slightly differs depending on customers because each customer's preference and property are different. Haircut becomes possible under the cooperation between providers and customers, and one cannot store haircut services. These attributes suggest that "many services require customers to participate in creating the service product" (Lovelock and Wirtz 2004, 11). Because of the service attributes, outsourcing in services sector had been limited to businesses whose

specification is easy such as electricity, water supply, and finance. In other words, if the fulfillment of service attributes changes, the tradability of the service would also change correspondingly.

Among four attributes, *heterogeneity* and *simultaneous production and consumption* play important roles on transaction cost and outsourcing decision. *Heterogeneity* means contents of services are different depending on each customer. Particularly, where the contract requires the client's specific knowledge or asset, *heterogeneity* is associated with "asset specificity" that causes small-numbers exchange and therefore, opportunism.

Simultaneous production and consumption means that services are produced and consumed simultaneously by the interaction of provider and customer. Therefore, it requires proximity of provider and customer. Additionally, it also means that the contents of services are not specified perfectly beforehand. Therefore, *Simultaneous production and consumption* is also associated to uncertainty and bounded rationality.

Service sector is becoming more and more important in the economy, but as seen in this section, characteristics as services have influences on transaction cost of the services. It is also noted that the distinction between manufacturing and services is becoming vague. Various products now include service components. On the other hand, some information services may also have the similarity to products. Cusumano (2010) phrases this as "the gradual "servitization of products" as well as the "productization of services"". In order to discuss the tradability of businesses including service elements, it is essential to analyze the attributes as services of the task.

3.2.3 Overall framework

Considering the theoretical foundation explained in this section, the analysis of this chapter

is based on the framework shown in Figure 3-1. This chapter views that the development of information technology reduces transaction cost of information services and enables these services to be tradable. In detail, the development of IT affects the service attributes of the object tasks. This change of service attributes affects two combinations of transaction costs. The one is small-numbers exchange and opportunism, and the other is uncertainty and bounded rationality. The change in the transaction costs affects the total outsourcing decision. Relationships of terms in service attributes and related concepts in transaction cost economics are also shown in Table 3-1.

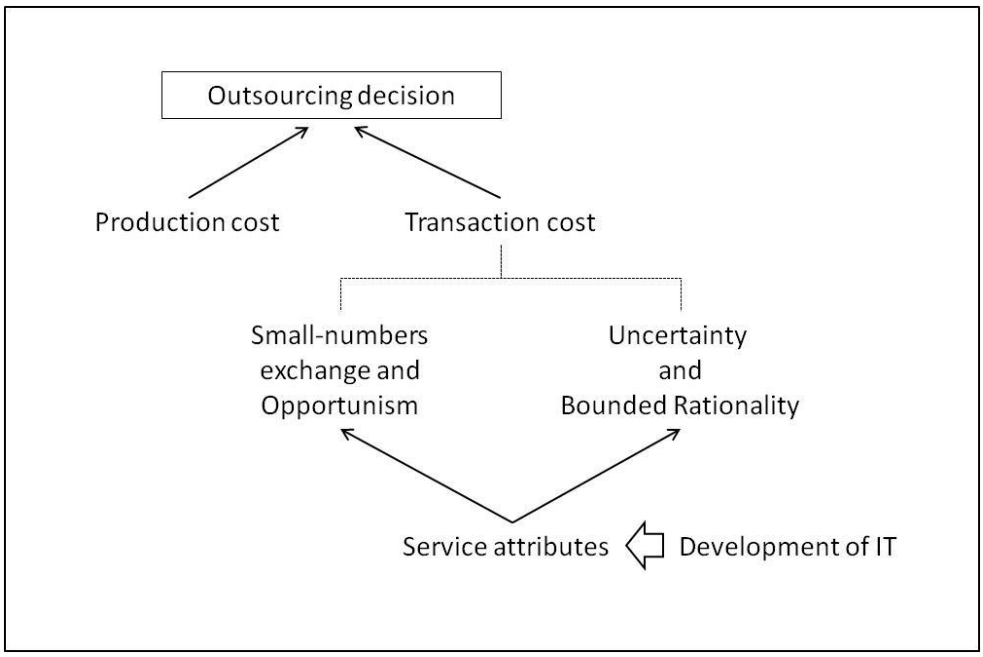

Figure 3-1. Framework of outsourcing decision

Table 3-1. Relationships of terms

Term in service attributes	Related attributes	Related term in Williamson (1975)	
		Environmental factor	Human factor
Heterogeneity	asset specificity	small-numbers exchange	opportunism
Simultaneous production and consumption	proximity	uncertainty	bounded rationality

3.3 Transaction Costs and Organizational Structure

This section discusses how information technology changes the service attributes of information services, and how the change in service attributes affects the transaction costs. At first, the scope of analysis is set based on the distinction of manufacturing and service, and the remaining of this section discusses how the change in the service attributes affects the transaction costs, which results in the choice on organizational structure.

3.3.1 Scope of analysis

When the economy is divided into the manufacturing and the services, outsourcing of business processes has four variations depending on the combination of client industry and outsourced business process. As Figure 3-2 shows this combination, manufacturing or service industry can outsource manufacturing or service function. When manufacturing sector outsources manufacturing function, it takes the form of intermediate components or OEM (Original Equipment Manufacturer) where manufacturing of final products is outsourced. Recently service firms also outsource manufacturing processes. For example, Malecki and Moriset (2008) show that Microsoft worked with Flextronics and various

EMS (Electronic Manufacturing Services) for the production of Xbox.

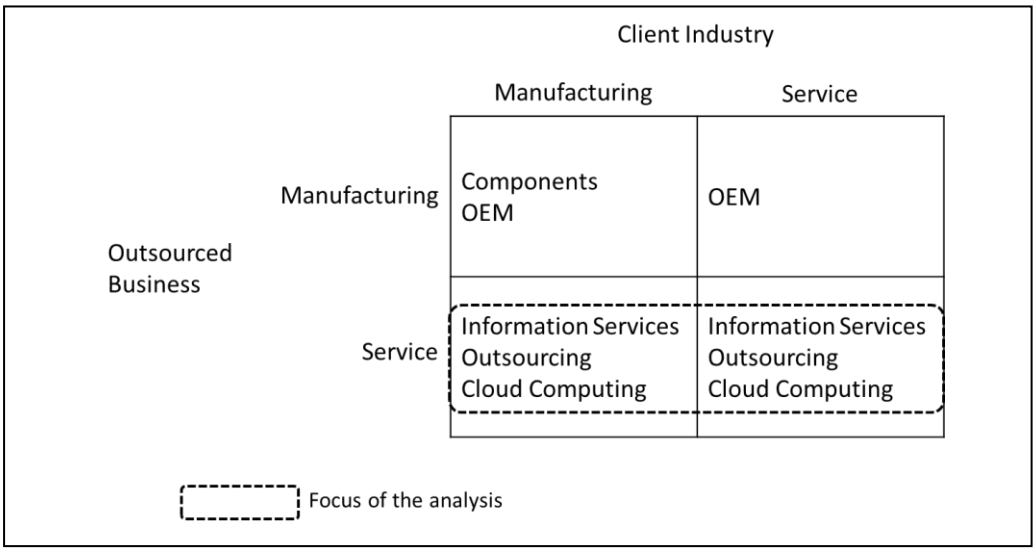

Figure 3-2. Scope of analysis

This chapter specifically focuses on the outsourcing of information services and computing services. These services can be outsourced both from manufacturing and service firms. Services such as sales management, human resources management and accounting are common services for most firms, and computing services are the platform for these services. Therefore, outsourcing of information services from manufacturing and service sector does not have the significant difference in terms of its contents and tradability. Based on this point, this chapter focuses on the outsourcing of information services and computing services from manufacturing and service sector, without specifying the difference between the client industries.

3.3.2 Heterogeneity and organization

As discussed earlier, heterogeneity is related to opportunism and small-numbers exchange. Usually when the risk of opportunism is high, the task is conducted in-house. However,

where outsourcing to overseas is still attractive because of the cost difference, the risk of opportunism affects the mode of outsourcing, rather than whether or not to outsource.

If there is the low level of *heterogeneity* and the corresponding risk of opportunism is low, the task is outsourced to third party vendors. However, where *heterogeneity* and the risk of opportunism are higher, the task is outsourced to the firms established or acquired by user firms to enjoy the cost reduction while mitigating the risk of opportunism. IPA (2012) shows that among Japanese IT service firms that have experiences to outsource software development services, 46.4% firms have established their own subsidiary companies one of whose services is to provide outsourced software development. The outsourcing to the subsidiary companies is called “captive sourcing” (Gottfredson et al. 2005, Baldia 2007). Captive sourcing combines the benefit of the cost reduction and the hierarchical control, while flexibility is less achieved than outsourcing to third party vendors.

3.3.3 Simultaneous production and consumption and organization

As discussed earlier, *simultaneous production and consumption* is related to uncertainty and required proximity between providers and customers. It is inferred that less *simultaneous production and consumption*, that means less uncertainty and proximity, promotes the outsourcing of the tasks.

The degree of uncertainty and required proximity is related to the decision on domestic or international outsourcing. If a buyer and a provider need a close communication and coordination on the activity, it is less easy to outsource the project to overseas, because of the difference of language, time zone, cultural norms, and business customs. Conversely, if required proximity becomes less important, it becomes easier to outsource the project to overseas.

How IT has reduced the required proximity is discussed in the following sections, but there is also other factor that reduces uncertainty and required proximity. For example, improvement of contract terms also affects the tradability of services. Blair et al. (2011) examined the contracts regarding outsourcing projects and showed that “some contract terms seem to work to thin the interactions between the firm and its service provider, and this thinning serves to make contracting for otherwise intrafirm services more feasible”. They identified several important features to reduce uncertainty such as “Master Agreement” plus “Statement of Work” structure, identifying a small number of key personnel as decision-makers, invoking or developing standardized metrics, codification of processes, and periodic evaluation of performance against standards (Blair et al. 2011). These contractual improvements also reduce uncertainty and required proximity in outsourcing projects.

3.3.4 Analytical tool

Taking into account the discussion in this section, the analytical tool is developed to operationalize the theories as shown in Figure 3-3. Vertical axis shows the degree of *heterogeneity*, that also shows the risk of opportunism. Horizontal axis shows the degree of *simultaneous production and consumption* that is related to uncertainty and proximity. Contents in dashed boxes (A to E) mean the choice of organizational structure that is suitable based on the service attributes.

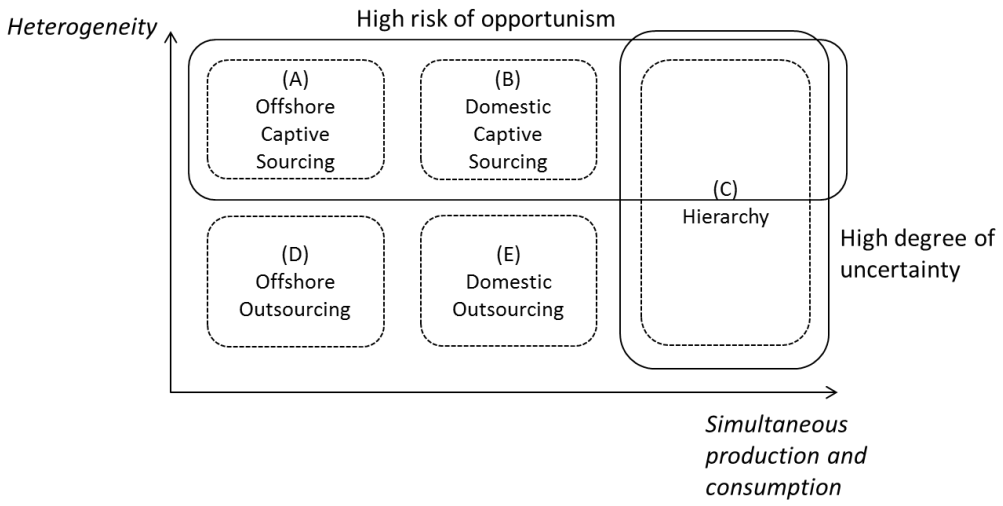

Figure 3-3. Analytical tools on outsourcing and service attributes

The upper and the right square faces the high risk of opportunism and the high degree of uncertainty. This situation force firms to conduct the task in hierarchy (C). When uncertainty is reduced and *heterogeneity* is high, firms have a choice to outsource the task to domestic subsidiary firms (domestic captive sourcing, B), or subsidiary firms that resides outside the country (offshore captive sourcing, A).

When uncertainty is high and opportunism is low, firms would still choose hierarchy (C). However, when heterogeneity is constantly low and uncertainty is reduced, firms have a choice to adopt domestic outsourcing (E) or offshore outsourcing (D).

3.4 Application of the Analytical Tool

This section experimentally applies the analytical tool that is introduced in the previous section and analyzes the choice of firms on outsourcing. The aim of this analysis is to better understand the effect of information technology on the firm's decision on organizational structure by using several cases: software development, call-center

operation, and cloud computing. The analysis is mainly based on the prior studies on the history of the related technologies and businesses.

3.4.1 Software development

In terms of software development, *heterogeneity* has been significant particularly for customized software projects, and close coordination of specification has been important in this business (Cataldo and Herbsleb 2013, Palacio et al. 2011, Gopal et al. 2011). The close coordination is still important for the outsourcing of software development, and mediation by bridge-SE (vendor's system engineer who resides in clients' location) is adopted in outsourcing projects (Umezawa, 2007). In this sense, *heterogeneity* has not changed. Therefore, the choice between captive or non-captive sourcing depends on the original level of heterogeneity of each project.

On the other hand, required *simultaneous production and consumption* has been reduced with the development of information technology such as TV conference and development management tools. For example, Palacio et al. (2011) provide a comprehensive survey on distributed software development (DSD). They propose the use of instant messaging (IM) and collaborative working spheres (CWS) to support communication, and the use of personal activity management (PAM) to help project management. In general, technologies to support communication, to manage source code and product, and to help project management are important to enable offshore outsourcing of software development. With the reduction of *simultaneous production and consumption*, firms are more likely to outsource the development process.

In Japanese context, the development of customized software is often outsourced from user firms to IT vendors, and from IT vendor to third party software companies (IPA 2011). This "multi-layer outsourcing" used to be conducted domestically, but outsourcing

to overseas has grown since early 2000s (IPA 2010). IPA (2011) points out that under the multi-layer outsourcing industrial structure, offshore outsourcing of software development has raised downward pressure of unit prices for small and medium size IT firms.

Based on this domestic background in Japan, software development has been conducted through domestic captive sourcing (B) or domestic outsourcing (E) as in Figure 3-4, depending on the heterogeneity of the software. Along with the reduction of *simultaneous production and consumption*, firms have a choice to take offshore captive sourcing (A) or offshore outsourcing (D). In order to reduce the risk of opportunism in offshore outsourcing project, offshore captive outsourcing (A) has been also one of the options. Usually captive sourcing is more costly than outsourcing, but the cost difference across countries may offset the cost associated to establishing subsidiary companies in abroad.

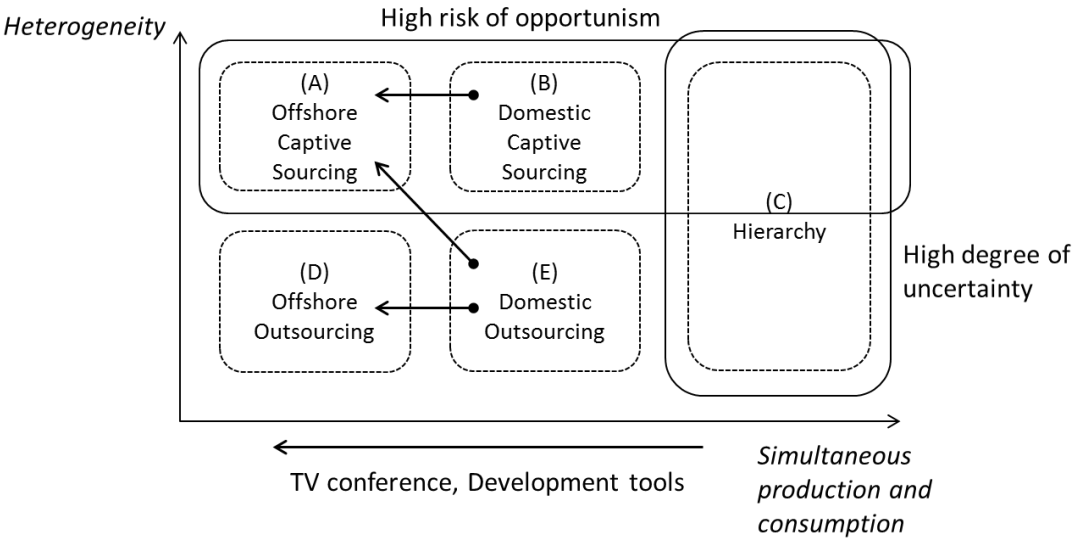

Figure 3-4. Organizational structure of software development

3.4.2 Call-center operation

In terms of call-center operation, s*imultaneous production and consumption* has also been reduced by the introduction of technology. Firms need to share customers' information among various sections including call-centers to meet the demand of customer. By the introduction of CRM (Customer Relationship Management) systems, call-centers in distant location and other departments can share the information on customers simultaneously.

CRM system is a computer system which is designed typically to support call-center operators to record and manage interactions with customers, but there are various functions in CRM systems. Torggler (2009) classifies the CRM systems by functions and the stage of business, and shows that CRM systems support various activities such as recording customer data, marketing support, complaint management, and data analysis for marketing, sales, and services. It is inferred that CRM systems provide various functions to manage data on customers and sales, but this data is used by various organizations such as marketing, sales, and customer support.

With the introduction of CRM, the record on customer support activity is simultaneously shared by headquarters and call-centers, and the summary of information can be reported periodically from call-center section. Thus the development of CRM systems has reduced s*imultaneous production and consumption* and required proximity between call centers and other departments.

Organizational structure for call-center operation is shown in Figure 3-5. Traditionally, call-center operation has been conducted within organization through hierarchy (C). Generally, development of IT such as CRM systems has reduced the *simultaneous production and consumption* attributes. On the other hand, there is a possibility that the penetration of CRM may promotes standardization of customer management business therefore reduce heterogeneity. However, the information on

customer transactions may be different for each firm. Therefore, choice between captive or non-captive sourcing depends on the level of heterogeneity in each firm.

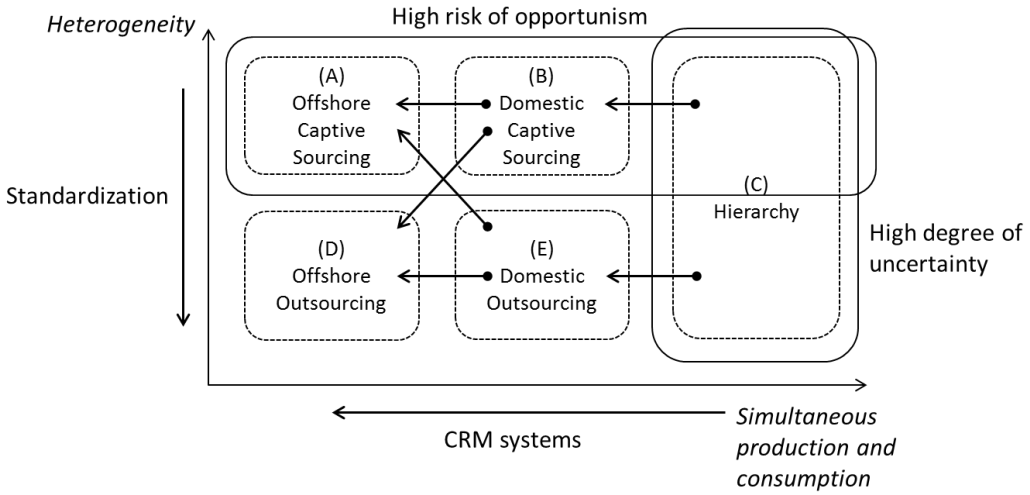

Figure 3-5. Organizational structure of call-center operation

3.4.3 Cloud computing

Computing services also used to be provided within organizations because of the customization for each organization. However, along with the convergence of optimal business processes, the provision of standardized services for a large volume of customers as the form of cloud computing became more economical.

For example, Bills (2013) shows that the ways to realize the value of cloud computing is through standardization and simplification, and raises several examples in which firms benefit from standardization of business process in the course of adopting cloud computing. McNeill et al. (2011) provide the result of the survey that shows that access to standardized business process is the motivation of outsourcing for 80% of user firms. This standardization reduces heterogeneity of computing services.

Additionally, the development of cloud computing is also related to the modularity of services. Baldwin and Clark (1997, 2000) introduced the concept of modularity to deal with complex systems. Modularity consists of sub elements: abstraction of functions, information hiding within each module, and interface to define the interaction between modules (Baldwin and Clark 1997). Public cloud computing is analogous to the modularity of computing services in terms of information hiding and specification of interface.

On the other hand, *virtualization*[6], one of technological innovations for cloud computing, enabled many firms to share the same computing resources. Additionally, the penetration of broadband network such as fiber-optics also enabled the responsive functionality in distant locations. Thus, virtualization and the improved network infrastructure have reduced the required proximity between the computing services and the user firms.

Organizational structure on cloud computing is shown in Figure 3-6. In terms of public cloud computing[7], the choice for firms is whether to use domestic or international cloud services (C to D or E). The choice between them depends on uncertainty and the requirement for close communication. If the service has more uncertainty and requires close communication, the firm would chose domestic outsourcing. Additionally, other factors such as regulation on personal information protection, or business contingency would also affect the choice between domestic or offshore outsourcing.

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[6] Virtualization is a technological element which enables users to utilize the shared computing resource as if the resource is used only by the user.

[7] On the difference of public, private, and hybrid cloud computing, see section 1.

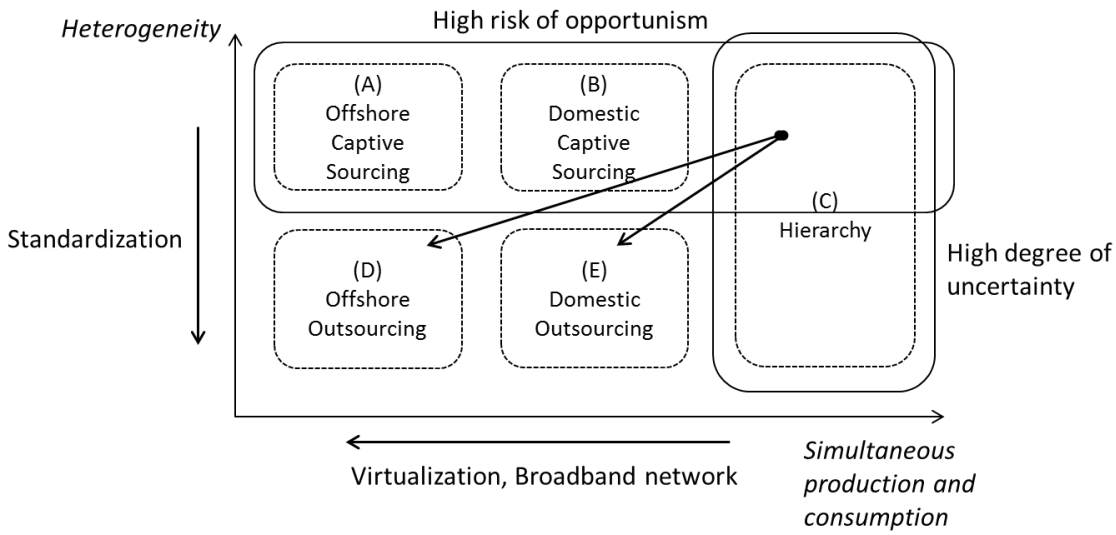


Figure 3-6. Organizational structure of cloud computing

As seen in the analyses in this section, generally information technology reduces *simultaneous production and consumption* and partly *heterogeneity* attributes. However, information technology also has the possibility to raise risks regarding outsourcing. For example, Gonzalez et al. (2008) list security problems as one of the risks of information systems outsourcing. They point out the importance of keeping confidentiality when providers are serving several competitors. Because the development of information technology has made it easier for information to be copied and transferred globally, the risk of security has become larger with the development of IT, which in turn restrains outsourcing.

3.5 Comparison of Three Cases

Previous sections analyzed the change in service attributes and transaction cost in each business cases: software development, call-center operation, and cloud computing. Then, how are these three cases different in terms of the absolute level of transaction costs? There is no effective way to measure the transaction costs across different cases, but from

analyses in previous sections, absolute level of heterogeneity and simultaneous production and consumption is compared as seen in Table 3-2.

Table 3-2. Comparison of three cases on transaction costs

Service attributes	Heterogeneity	Simultaneous production and consumption
Factors to lower the attributes	Standardization	Communication network and tools
Software development	High	High
Call-center operation (BPO: Business process outsourcing)	Middle	Middle
Cloud computing	Low	Low

As discussed previously, *heterogeneity* of software development is traditionally high, because of the required coordination for customization. Level of *simultaneous production and consumption* is also high, but it can be reduced by the introduction of communication tools.

On the other hand, cloud computing is the result of standardization of business processes, which reduces *heterogeneity*. It is also the result of virtualization and broadband networks, which reduce the requirement for *simultaneous production and consumption*. In a sense, cloud computing is the result of the effort to reduce transaction cost for information services, therefore, the absolute levels of both of service attributes are low.

Call-center operation, or in general business process outsourcing, falls somewhere between software development and cloud computing. Compared to software development,

call-center operation could be more standardized, because customization is less frequent or comprehensive. However, its service attributes are higher than cloud computing, because it is not fully computerized and needs to be conducted manually by human staffs.

Therefore, comparing three cases, transaction cost is highest in software development, and medium for business process outsourcing, and lowest for cloud computing. This comparison is referred in the following chapters together with the results of the analyses in each chapter.

3.6 Conclusion

This chapter analyzed the mechanisms behind the firm's decision on outsourcing of information services, using transaction cost economics and service attributes. It showed that how the development of IT has affected the structure of business organizations, through the decision on outsourcing. Particularly, the analysis showed that the change in service attributes such as *heterogeneity* and *simultaneous production and consumption* play the important roles for outsourcing decision. It also discussed that standardization is important factor to affect *heterogeneity*, and communication networks and tools are important factors for *simultaneous production and consumption*. Practically, the promotion of outsourcing of information services is determined by standardization and communication networks and tools. Compared to prior studies, this chapter discussed information technology as an enabler of outsourcing, and analyzed the effect of information technology on the firm's decision on organizational structures.

Standardization is also an important topic as an industry policy. Standardization of CRM or cloud computing evolves when major suppliers provide services to more customers, which could result in *de facto* standard. In terms of software development, standardization on development processes, quality management, and IT skills are discussed

both in national and international level, which result in various *de jure* standard such as adopted by International Organization for Standardization. From economic policy's point of view, it is important to be conscious on what services could be standardized and likely to be subject of outsourcing, in order to compose the effective industry and employment policy.

There are several limitations in this analysis. As the experimental application of the analytical tool shows, there could be other factors which can affect outsourcing decisions. For example, regulation on data protection, information security, core competency of firms, effect on knowledge creation and spillover are the candidates among them. It is one of the future challenges to include these aspects with transaction cost analysis.

In order to achieve the goal of this dissertation which is the assessment of the impact of IT on the economy through organizational changes, this chapter provided the fundamental view on the relationship between IT and organizational structure. Particularly, this chapter discussed how IT affects organizational structures in terms of several modes of organizational structure, and the difference of tradability of several information services, such as software development, call-center operation, and cloud computing. The following chapters pick up the specific form of outsourcing and organizational changes and assess the effects on macroeconomic variables. The implications of the following analyses are discussed in each chapter, combined with the insights on tradability and organizational structure which are provided in this chapter.

4. Offshore Outsourcing of Information Services and Employment[1]

Based on the organizational view which is presented in the previous chapter, the discussion enters the assessment on the impact of organizational change on the economy. This chapter focuses on the "past" stage, focusing on offshore outsourcing of information services to overseas. It empirically assesses the impact of offshore outsourcing on Japanese employment during 2002 to 2006, specifying the partner countries to which the services are outsourced. Additionally, partner countries are related to the objective business processes which are outsourced from Japan. The results show that information services outsourcing affect employment in manufacturing sector in Japan, but the impact is different depending on trading partners. In particular, the outsourcing to OECD countries reduces employment in Japan. On the other hand, the outsourcing to China increases, and outsourcing to India reduces manufacturing employment in Japan. The different impact across trading partners is discussed to relating to object of trade, such as software development, cloud computing, and business process outsourcing.

4.1 Introduction

Since the turn of the new millennium, pervasive use of ICT has changed business ways in almost all industries. Since the middle of 2000s especially, ICT has played a role in rebuilding organizational networks by connecting value chains and providing communication networks with drastically lower costs. This change has two important aspects. First, the use of ICT has lowered the cost to build production networks across distant locations and across borders. Second, ICT has made certain types of services tradable, which used to be non-tradable and had to be produced at the same location of consumption.

[1] This chapter is based on Takagi and Tanaka (2011) and Takagi and Tanaka (2014) which are restructured and revised for this dissertation.

For example, software development, software-related research and development (R&D), and system operations, can be performed in distant locations as long as they are connected to communication networks. On the other hand, information services such as call-center operations, data entry, and financial processing also became possible to be performed in distant locations as the form of BPO (Business Process Outsourcing). Recently, computing resources with packaged services are also outsourced as the form of cloud computing. As a result, the value chain of many types of services have been fragmented and transferred across borders. These services together are called "information services" unless otherwise noted. The outsourcing of services to providers overseas is called "offshoring" or "offshore outsourcing".

The fragmentation of the production network of information services has been led by the U.S. firms which have outsourced their services to countries, such as India, Ireland, and Israel. Those new types of trade are spreading to East Asia, typically in outsourcing from Japan to China and ASEAN countries. According to IPA (2011), Japanese IT-service firms are outsourcing their software development processes mostly to China, India, the Philippines, and Vietnam in Asian developing countries[2].

As in the U.S., the trend of offshore outsourcing has raised concerns on its effect on employment, labor structure and growth strategy in Japan. According to IPA (2011), although the share of the outsourcing of software development services from Japan is under 1% of the overall market, offshoring is affecting the industry in ways such as the downward pressure of unit cost and the need for Japanese firms to shift to more upstream processes[3].

However, employment which is involved in information services includes diverse knowledge and skills. Some business process, for example R&D requires high-level

[2] IPA (2011), p.109
[3] IPA (2011), p.139

knowledge and skills, and countries need to invest in higher education for the long term to raise the capacity of R&D. On the other hand, testing and operations and system management are generally considered as more labor-intensive processes. Therefore, it is important to identify which business processes are outsourced, in order to assess the impact on labor composition and the industrial structure of developed countries.

Figure 4-1 shows the components of information services. Software development follows the business process flow from consulting & strategy, design, development, to the start of operations. R&D affects all of these processes by improving the business process and also by providing new software components and ideas. Business process outsourcing such as outsourcing of call-center operations and financial processing is one of the results of the development of software and information systems. Cloud computing services are also enabled by the utilization of cutting-edge technology and are closely related to R&D.

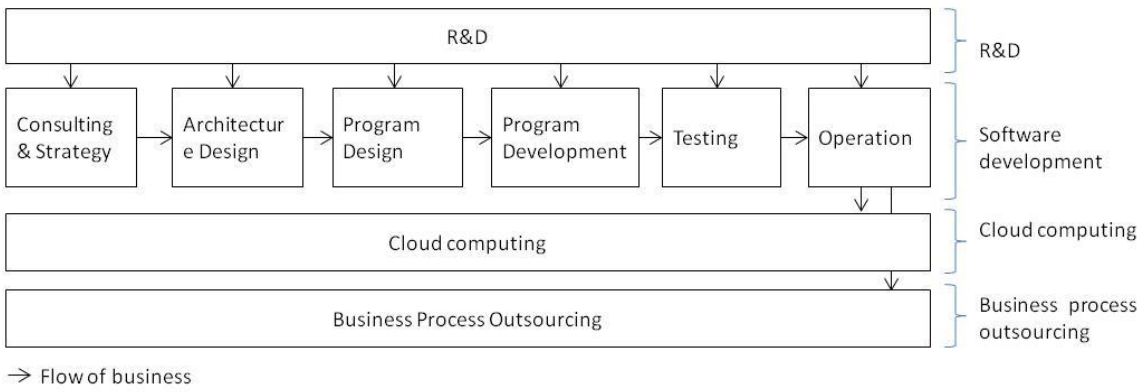


Figure 4-1. Components of information services

In order to examine the difference of the effect of offshore outsourcing on the economy across trading partners, the amount of offshore outsourcing and its effect are

analyzed in the following sections based on the available data. There is no clear way to identify which business processes are outsourced to which countries, but IPA (2011) provides the result of survey on the processes which are outsourced from Japan to several countries. It shows that China, India, Vietnam and the Philippines provide services from program design to testing, but the share of architecture design and more comprehensive testing is increasing. The survey also reports that India is increasing more high-skilled process such as R&D.

Outsourcing of information services to China also has a unique advantage. Nikkei Sangyo Shinbun (2014) reports that more than 10,000 Chinese workers process Japanese manuscripts based on the knowledge of Chinese characters (*Kanji*). It reports that from insurance payment, accounting, human resource management, to patent, Chinese workers have advantages in handling these documents, performing low rate of typo which is 0.01% among Chinese workers, whereas 10% in Japanese workers.

Taking the report of IPA (2011) into account, this chapter assumes that countries and country groups provide certain business processes as shown in Table 4-1. First, in order to identify the difference between high-cost countries and low-cost countries, OECD and Non-OECD are identified. Among Non-OECD counties, China is identified because of the unique characteristics of lingual proximity as stated above. India is also identified, because it has a growing software and information services industry, and it is the major exporter of computer and information services to the U.S. (Takagi 2011). The category of ASEAN6 is identified to include Indonesia, Malaysia, the Philippines, Singapore, Thailand, Vietnam as shown in Table 4-2. Only these 6 countries are included because of the data availability, but note that Singapore, which is advanced in terms of utilizing information technology, represents the major part of the information services trade with Japan among these 6 countries. The U.S. is also identified, because it is one of the central markets of

information services, and it would worth to check the results comparing other countries.

This chapter considers the exporting countries and country groups as the proxies of business processes which are outsourced to each country and country groups. By relating countries and outsourced business processes, this chapter addresses the question of how outsourcing to certain countries, in other words, the outsourcing of certain services, affects employment in Japan.

Table 4-1. The relation of countries and the outsourced business process

	R&D	Consulting & Strategy	Architecture Design	Program Design	Program Development	Testing	Operation	Cloud computing	BPO
OECD	○	−	−	−	−	−	−	○	−
Non-OECD	−	−	−	○	○	○	○	−	○
China	−	−	−	○	○	○	○	−	○
India	△	−	−	○	○	○	○	−	○
ASEAN6	△	−	−	○	○	○	○	△	○
U.S.	○	−	−	−	−	−	−	○	−

○:Countries that focus on providing the business processes. △:Countries that do not focus on the business processes, but also provide the business processes. −:Countries that do not provide the business processes.

4.2 Measurement Methodology

This analysis applies a similar approach as Takagi and Tanaka (2012c) to estimate the outsourcing of information services, but specifies the countries which export information services to Japan.

This analysis calculates the amount of offshore outsourcing from the input-output table following Falk and Walfmayr (2008). The input-output table is obtained from JIP 2009 database (RIETI 2009). Two types of offshoring are defined in this analysis. The first is “Traditional outsourcing”, which is assessed as imported intermediate inputs in the same

industry. It is called "Traditional outsourcing" because it typically assesses the outsourcing of manufacturing goods which are imported from overseas and sold to a domestic industry which is in the same industrial sector. Because the imported product is sold to the same industry, it is assumed that the domestic industry is outsourcing the production process to overseas. This idea of measurement is first introduced by Feenstra and Hanson (1996, 1999)[4], and applied by Falk and Walfmayr (2008). The calculation of traditional outsourcing is described as follows:

Traditional outsourcing of goods i =

$$[input\ purchases\ of\ good\ j\ by\ goods\ i] * \left[\frac{imports\ of\ good\ j}{total\ domestic\ demand\ of\ good\ j} \right]$$

where $i = j$

Traditional outsourcing of industry *i* is calculated as input purchases of good *j* by industry *i* times the import ratio of industry *j* (imports of good *j* divided by the total domestic demand of good *j*).

The second type of outsourcing is "information services outsourcing". This is assessed as imported intermediate inputs of "Information services" for each industry. The calculation is described as follows:

Information services outsourcing of industry i=

$$[input\ purchases\ of\ Information\ services\ by\ industry\ i] * \left[\frac{imports\ of\ Information\ sevices}{total\ domestic\ demand\ of\ Information\ services} \right]$$

[4] Falk and Walfmayr (2008)

Information services outsourcing of industry *i* is calculated as input purchases of information services by industry *i* times the import ratio of information services (imports of information services divided by total domestic demand of information services). This measurement follows a similar approach as traditional outsourcing, but specifically focuses on the outsourcing of information services.

JIP2009 database provides the share of 32 countries and regions which export information services to Japan each year. Therefore, the amounts of imports from each country are calculated by multiplying the total amount by the share of each country. Because China, India, and the U.S. have a significant presence as exporters to Japan, imports from those countries are specified[5]. Imports from country groups such as the OECD and ASEAN6 are also calculated. Only countries whose data is available in the JIP 2009 are included in the analysis. The exporting countries and country groups which are assessed in the analysis are summarized in Table 4-2.

Table 4-2. Exporting countries and country groups in the analysis

Country / Country groups	Notes
OECD	Australia, Belgium, Canada, France, Germany, Italy, Korea, Luxembourg, Mexico, Netherland, New Zealand, Spain, Sweden, Switzerland, UK, U.S.
Non-OECD	Brazil, Cayman Islands, China, Hong Kong, India, Indonesia, Iran, Malaysia, Philippines, Russia, Saudi Arabia, Singapore, South Africa, Thailand, UAE, Vietnam
ASEAN6	Indonesia, Malaysia, Philippines, Singapore, Thailand, Vietnam
China	China
India	India
U.S.	The United States

[5] Liu and Trefler (2008) focus more specifically on trade with China and India, because public concern is concentrated on trade with the two countries.

There are several limitations in this measurement of outsourcing. First, the same import ratio is applied to all industries and also on final consumption. In some industries, import might be designated mostly to final consumption, and others might be designated to intermediate input of a specific industry. Because it is impossible to distinguish the weight of imports across the industries and final consumption, the same import ratio is applied for all industries.

Second, it is impossible to capture outsourced production which is exported to other countries. Suppose that a product is manufactured in a foreign country under Japanese company's control, then exported to a third party country. This transaction does not appear to input-output table of the Japanese economy.

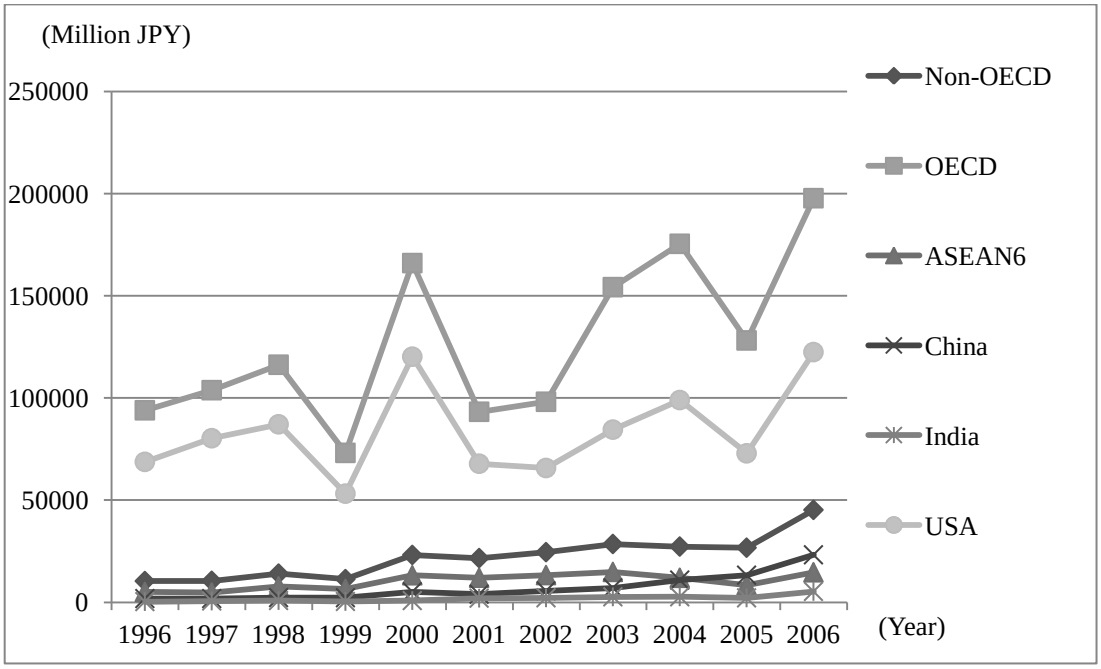
Third, it is also impossible to distinguish between foreign production under the control of a Japanese purchaser and production under foreign control. If some imported intermediate product is manufactured under Japanese company's control, it is easily called as outsourcing. However, if the imported intermediate product is produced under the control of the exporting country, it is not as clear as the former case to call it as outsourcing. There is no clear line to distinguish outsourcing based on the extent of domestic control, but various types of production might be included in the measurement.

However, given the difficulty in measuring the offshore outsourcing, it is still meaningful to conduct analyses with the best available data and measurement methodology. Major prior studies also employ the same approach considering the same limitations. Therefore, this research also uses this approach enabling comparison with prior studies.

4.3 Trend of Outsourcing

Figure 4-2 shows the trend of the absolute value of import from each country and country group. Although there is a fluctuation in the period, it shows the general trend of increase

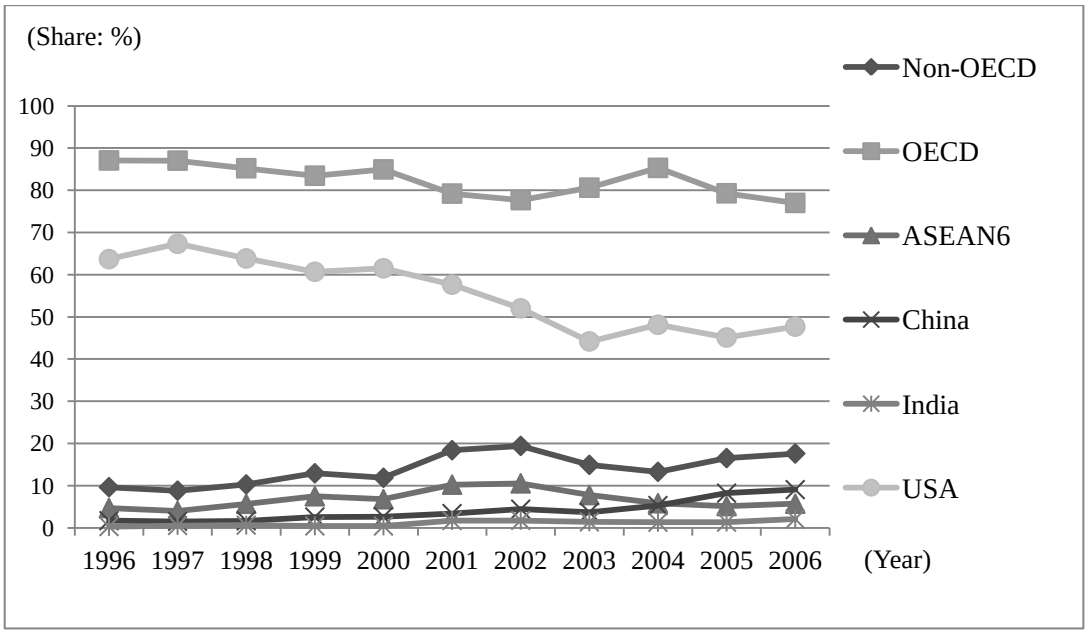
in the amount from most countries.



Source: JIP 2009 database (RIETI 2009)

Figure 4-2. Trend of values of imports from source countries (million JPY)

Figure 4-3 shows the trend of the share of countries which export information services to Japan. It shows that the general trend of import from high-cost countries has declined, and import from low-cost countries has increased throughout the period. Particularly, the share of the U.S. surpassed 60% in the late 1990s, but it has fallen to below 50% in the mid-2000s. On the other hand, import from Non-OECD countries increased during the same period. In particular, China increased its share from less than 1.7% in 1996 to around 9.1% in 2006.



Source: JIP 2009 database (RIETI 2009)

Figure 4-3. Trend of share of exporting countries

4.4 Estimation of the Effect on Employment

This section assesses the effect of the outsourcing of information services to specific countries or regions on employment in Japan. By using the amount of offshore outsourcing obtained in the previous sections, this section estimates the effect by panel data analysis.

4.4.1 Estimation models

The estimation model is based on the conventional labor demand model and is described as follows:

$$\Delta L_{it} = \alpha_0 + \alpha_1 \Delta Y_{it} + \alpha_2 \Delta W_{it} + \alpha_3 \Delta TDO_{it} + \alpha_4 \Delta ITinv_{it} + \alpha_c \Delta SER_{cit} + v_i + e_{it} \qquad (4\text{-}1)$$

where delta is the ratio from the previous year, i is industry, t is year. L is employment, Y

denotes value added, and *W* is real wage. *TDO* denotes traditional outsourcing. *SER* denotes information services outsourcing which is decomposed into each country and region, *c*. The combination of countries and regions are selected to avoid duplication. The error term is divided into industry effect as v_i and error term e_{it}. The effect is estimated for all industries, manufacturing industries, and service industries separately.

Lagged variation is derived from the estimation model (4-1). Estimation model (4-1) assesses the contemporaneous effect of outsourcing on employment. However, it may take a while until the transition of the business process is settled and those transitions actually affect employment. In the lagged model, outsourcing variables of one year before the dependent variables are used as explanatory variables. Similarly, lagged data of Y is also used because companies might react to the expansion of output by overtime work in the first year, and they may hire more employees the next year. Lagged data of W is also used because it might also take time until the variation of wages affects employment. The lagged model is described as follows:

$$\Delta L_{it} = \alpha_0 + \alpha_1 \Delta Y_{it-1} + \alpha_2 \Delta W_{it-1} + \alpha_3 \Delta TDO_{it-1} + \alpha_4 \Delta ITinv_{it-1} + \alpha_c \Delta SER_{cit-1} + v_i + e_{it} \qquad (4\text{-}2)$$

Year coverage is 5 years from 2002 to 2006. In Japan, offshore outsourcing of information services became popular around this period. To compare the results with the more previous years, the analysis is also applied to dataset which covers from 1998 to 2001. During this period, offshore outsourcing became popular in the U.S. because of the labor shortage to address Y2K issue, but offshore outsourcing was not so popular in Japan.

The estimation has four variations for the combination of explanatory variables. Variation [1] uses total information services outsourcing without country specification.

Variation [2] decomposes exporting countries into the OECD and Non-OECD countries. Variation [3] decomposes Non-OECD countries to China, India, and ASEAN6 countries. Variation [4] uses the U.S. instead of OECD countries.

In the estimation of coefficients, fixed effect model is employed by the following reasons. First, either fixed or random effect model has to be selected throughout the contemporaneous and the lagged model in order to make a comparison across these multiple models. Secondly, it is assumed that each firm has a relatively stable and unique adaptability to offshore outsourcing. Because of these reasons, fixed effect model is employment both on the contemporaneous and the lagged model.[6]

The summary of statistics is shown in Appendix 4-A and correlation matrix is shown in Appendix 4-B. The outlier is eliminated once from dataset by the standard that values are within the means plus/minus four standard deviations.

4.4.2 Results

Tables 4-3 and Table 4-4 show the result of the estimation. The estimation was conducted using STATA/IC 11.2. Because it is assumed that it takes a while until the increase of outsourcing affects employment, the following discussion is based on the lagged model in Table 4-4.

First, significant effects of information services outsourcing are found in coefficients in the manufacturing sector. There is no significant effect in the service sector, and the adjusted R-squared is also higher in the manufacturing sector than in the service sector.

[6] The results of Hausman test are shown in Tables 4-3 and 4-4 which was conducted with the sigmamore option using STATA/IC 11.2. Generally, fixed effect model is supported for “All Industries” and “Manufacturing”, and random effect model is supported for “Services”, but fixed effect model is employed throughout the analyses based on the reasons stated in this section. Estimation with random effect model is also applied on the specification which fixed effect model is less applicable such as [1] to [4] of service sector in Table 4-3 and [1] to [4] of service sector in Table 4-4, but the results do not affect the following discussion.

Focusing on manufacturing sector, variation [1] shows that information services outsourcing as a total has a negative effect on employment. By decomposing the exporting countries into OECD and Non-OECD countries in variation [2], outsourcing to OECD countries has negative effect on employment, and outsourcing to Non-OECD countries has no significant effect. However, if Non-OECD countries are further decomposed into China, India, and ASEAN6 in variation [3], outsourcing to China has a positive effect, while India and ASEAN6 have negative effects on manufacturing employment. In variation [4] outsourcing to the U.S. has almost the same negative effect as the OECD.

In terms of comparison with the contemporaneous model in Table 4-3, the negative effect of outsourcing to OECD countries in the lagged model is also detected in the contemporaneous model in Table 4-3. However, the negative effect of outsourcing to India was positive in the contemporaneous model.

Table 4-3. Results of estimation (Contemporaneous model), 2002-2006

	All Industries				Manufacturing				Services			
	[1]	[2]	[3]	[4]	[1]	[2]	[3]	[4]	[1]	[2]	[3]	[4]
Wage	0.080	0.065	0.084	0.085	0.189**	0.175***	0.274***	0.278***	0.027	0.017	0.003	0.003
	(0.062)	(0.055)	(0.072)	(0.071)	(0.079)	(0.064)	(0.077)	(0.078)	(0.089)	(0.085)	(0.088)	(0.089)
Value added	0.016	0.025	0.010	0.011	0.020	0.038**	0.016	0.019	-0.032	-0.030	-0.055	-0.056
	(0.017)	(0.016)	(0.015)	(0.015)	(0.018)	(0.017)	(0.016)	(0.016)	(0.040)	(0.042)	(0.047)	(0.047)
Traditional outsourcing	0.007	0.011	0.003	0.004	0.014	0.022	-0.004	-0.003	0.010	0.010	0.012	0.012
	(0.009)	(0.009)	(0.008)	(0.008)	(0.015)	(0.013)	(0.014)	(0.014)	(0.009)	(0.009)	(0.010)	(0.010)
IT investment	-0.001	-0.009	-0.005	-0.006	0.014	-0.001	0.014	0.012	0.007	0.007	0.003	0.003
	(0.010)	(0.009)	(0.010)	(0.010)	(0.011)	(0.010)	(0.012)	(0.012)	(0.015)	(0.015)	(0.012)	(0.012)
Information services outsourcing	0.025***				0.040***				0.003			
To:	(0.005)				(0.007)				(0.008)			
OECD		-0.014**	0.002			-0.021***	0.001			-0.002	0.003	
		(0.007)	(0.008)			(0.007)	(0.009)			(0.013)	(0.013)	
Non-OECD		0.058***				0.084***				0.008		
		(0.008)				(0.008)				(0.015)		
China			-0.008	-0.006			-0.004	-0.001			-0.017	-0.019
			(0.017)	(0.017)			(0.023)	(0.024)			(0.023)	(0.019)
India			0.087***	0.087***			0.126***	0.126***			0.039**	0.037
			(0.015)	(0.015)			(0.023)	(0.021)			(0.017)	(0.023)
ASEAN6			-0.104***	-0.101***			-0.155***	-0.150***			-0.050***	-0.048***
			(0.019)	(0.018)			(0.033)	(0.030)			(0.012)	(0.016)
U.S.				-0.004				-0.006				0.005
				(0.013)				(0.013)				(0.021)
constant	0.849***	0.838***	0.900***	0.899***	0.688***	0.667***	0.679***	0.673***	0.980***	0.985***	1.060***	1.061***
	(0.068)	(0.061)	(0.087)	(0.086)	(0.093)	(0.076)	(0.094)	(0.095)	(0.086)	(0.082)	(0.109)	(0.107)
N	408	408	408	408	245	245	245	245	135	135	135	135
R2(Within)	0.074	0.175	0.250	0.250	0.161	0.349	0.479	0.479	0.026	0.029	0.078	0.078
Adjusted R2	0.330	0.401	0.452	0.452	0.394	0.527	0.617	0.618	0.262	0.257	0.280	0.280
Hausman test	17.14	17.19	29.93	29.92	18.66	24.79	31.52	30.32	2.51	2.71	5.32	5.27
χ^2 (p)	(0.0042)	(0.0086)	(0.0002)	(0.0002)	(0.0022)	(0.0004)	(0.0001)	(0.0002)	(0.7750)	(0.8441)	(0.7225)	(0.7288)

Robust standard errors in parentheses. * p<0.10 ** p< 0.05 *** p<0.01. Adjusted R-squared are calculated by least-squares dummy-variables regression.

Table 4-4. Results of estimation (Lagged model), 2002-2006

	All Industries				Manufacturing				Services			
	[1]	[2]	[3]	[4]	[1]	[2]	[3]	[4]	[1]	[2]	[3]	[4]
Wage	0.285***	0.282***	0.186**	0.186**	0.514***	0.500***	0.291***	0.282***	0.234**	0.241**	0.198**	0.198**
	(0.079)	(0.081)	(0.078)	(0.078)	(0.073)	(0.074)	(0.059)	(0.058)	(0.093)	(0.097)	(0.076)	(0.076)
Value added	0.064***	0.064***	0.036*	0.037*	0.059**	0.060**	0.031	0.031	-0.049	-0.052	-0.073	-0.073
	(0.023)	(0.023)	(0.022)	(0.022)	(0.024)	(0.024)	(0.020)	(0.020)	(0.050)	(0.049)	(0.057)	(0.057)
Traditional outsourcing	0.010*	0.011*	0.004	0.004	0.024**	0.026**	0.014*	0.014*	-0.000	-0.000	-0.001	-0.001
	(0.006)	(0.006)	(0.006)	(0.006)	(0.012)	(0.012)	(0.008)	(0.008)	(0.005)	(0.005)	(0.006)	(0.006)
IT investment	0.016*	0.016*	0.006	0.006	0.010	0.009	-0.024**	-0.025**	0.018	0.017	0.022*	0.022*
	(0.008)	(0.009)	(0.009)	(0.009)	(0.009)	(0.010)	(0.010)	(0.010)	(0.014)	(0.014)	(0.013)	(0.013)
Information services outsourcing	-0.007				-0.023***				0.005			
To:	(0.005)				(0.008)				(0.005)			
OECD		-0.008	-0.011*			-0.021**	-0.034***			0.009	0.007	
		(0.006)	(0.006)			(0.010)	(0.010)			(0.006)	(0.008)	
Non-OECD		0.006				0.006				-0.020		
		(0.020)				(0.031)				(0.029)		
China			0.016	0.025*			0.027*	0.051***			-0.011	-0.014
			(0.012)	(0.013)			(0.016)	(0.019)			(0.018)	(0.017)
India			-0.015**	-0.013**			-0.026***	-0.020**			-0.010	-0.011
			(0.006)	(0.006)			(0.008)	(0.008)			(0.008)	(0.008)
ASEAN6			-0.030**	-0.032***			-0.029*	-0.041***			-0.010	-0.007
			(0.013)	(0.012)			(0.015)	(0.013)			(0.025)	(0.023)
U.S.				-0.019**				-0.051***				0.008
				(0.008)				(0.014)				(0.011)
constant	0.612***	0.609***	0.788***	0.783***	0.387***	0.393***	0.727***	0.725***	0.793***	0.807***	0.885***	0.886***
	(0.068)	(0.067)	(0.076)	(0.076)	(0.070)	(0.069)	(0.071)	(0.072)	(0.089)	(0.094)	(0.098)	(0.098)
N	404	404	404	404	241	241	241	241	136	136	136	136
R2(Within)	0.135	0.137	0.281	0.283	0.234	0.236	0.516	0.521	0.138	0.144	0.186	0.185
Adjusted R2	0.385	0.383	0.483	0.485	0.453	0.452	0.649	0.652	0.382	0.380	0.399	0.398
Hausman test	17.86	17.02	24.02	23.37	17.20	16.61	27.85	26.54	5.53	5.43	6.59	6.64
χ^2 (p)	(0.0031)	(0.0092)	(0.0023)	(0.0029)	(0.0041)	(0.0108)	(0.0005)	(0.0008)	(0.3546)	(0.4902)	(0.5814)	(0.5761)

Robust standard errors in parentheses. * p<0.10 ** p< 0.05 *** p<0.01. Adjusted R-squared are calculated by least-squares dummy-variables regression.

4.5 Discussion

The first feature of the results is that information services outsourcing affects the manufacturing sector, not the service sector. This effect has already been pointed out in Takagi and Tanaka (2012c). This result indicates the following possibilities. Although information services are one of the service industries, the actual business of information services is also used in the manufacturing sector. Because recent manufacturing products are full of software and after-service component, information services outsourcing affects manufacturing sector. Information services in manufacturing sector is far from its core-competence, therefore, outsourcing might has affected employment in manufacturing sector.

Significant results in the manufacturing sector with country specification in the lagged model suggest interesting possibilities. Results in the decomposed countries to the OECD and Non-OECD in variation [2], and the U.S. and other countries in variation [4], show that outsourcing to high-cost and developed countries substitutes for employment in Japan. It is reasonable to suppose that the skills and costs of labour in Japan are similar to other OECD countries. Therefore, outsourcing to those countries might reduce employment in Japan. Falk and Walfmayr (2008), who also specify outsourcing to high-wage and low-wage countries from EU countries, found import from low-wage countries has significant and negative effects on employment in the service sector. The results of the analysis contradict this prior study.

One of the important findings in this analysis is that the outsourcing to Asia is not homogenous across countries. First, outsourcing to China seems to complement employment in Japan. Because skill and cost of labour in China is different significantly from those in Japan, outsourcing to China might contribute to the growth of the industry in Japan. In addition to the difference, geographical or lingual proximity between China and

Japan as discussed in section 4.1 would also explain the benefit of outsourcing to China.

On the other hand, outsourcing to India substitutes for employment in Japan. India is a major exporter of computing and information services to the U.S., but the amount of offshore outsourcing from Japan to India is very limited compared to China, as seen in Figure 4-2. This might be due to the difference of language, geographical distance, and general experience of cooperation on business. In terms of negative effect, India is increasing services of high-skilled process such as R&D (IPA 2011). This might show the substituting relation with Japanese employment.

The reason for the negative effect of outsourcing to ASEAN6 is not clear, but Singapore which provides high-cost and high-skilled services is included in ASEAN6 countries. More than half of ASEAN6 share of information services outsourcing is to Singapore, so this might has affected employment in Japan for the same reason as the OECD and the U.S.

Most of the significant effects of information services outsourcing are not found in the previous period, 1998-2001. Because offshore outsourcing became popular after this period in Japan, significant effects on employment are considered as the effects by the increase of offshore outsourcing of information services.

As stated in the introduction, this chapter assumes that the OECD and the U.S. provide R&D or cloud computing. On the other hand, China, India and ASEAN6 mainly focus on software development processes such as program design to operation, and Business Process Outsourcing, although India and Singapore have the possibility to provide R&D and cloud computing. If this becomes the case, the outsourcing of R&D and cloud computing reduces manufacturing employment in Japan, and the outsourcing of software development processes increases manufacturing employment in Japan.

However, the positive effect of offshore outsourcing of software development on

employment is not necessarily applicable also in the future. As seen in Chapter 3, standardization of businesses and the development of communication networks are promoting cloud computing. Cloud computing is the alternative to customized software, but still requires software development processes to construct cloud computing services. Cloud computing providers need to construct and continuously improve their own services to meet the demand of customers and various social requirements. This software development processes for cloud computing would need the best available skills to compete against other providers globally. Therefore, when the software development process is used for constructing cloud computing, in-house development rather than offshore outsourced would be more required and rationalized in terms of flexibility and agility.

Related to this point, it is inferred from the results that outsourcing of R&D and cloud computing reduces employment in Japan, which would leads to the reduction of high-skilled labour in the field. This might reduce not only the employment in Japan but also the innovation capability of Japanese information industry. If this is the case, promoting R&D in domestic entities and locating data centers in Japan is one of the options to consider as a public policy. Taking into consideration the above argument on software development for cloud computing, the empirical results should be interpreted considering the development of technology and business models. For instance, there would be diverse skills and roles in software development, and a part of them might be an important element for other sources of growth in the future.

4.6 Conclusion

This chapter provides statistical evidence to assess the effect of offshore outsourcing on employment in Japan, specifying the difference across trading partners. The analysis

revealed that the effect is diverse depending on trading partners, particularly when decomposing trading partners to China, India and ASEAN6. Outsourcing to China seems to increase, and outsourcing to India and ASEAN6 reduces employment in Japan.

Interpreting this results on business processes, outsourcing of high-skilled services such as R&D and cloud computing seems to reduce manufacturing employment in Japan, and outsourcing of software development processes increases manufacturing employment in Japan. Analysis on organizational view in Chapter 3 suggested that transaction costs are lower and easier to outsource for cloud computing than software development or business process outsourcing. If offshore outsourcing of cloud computing can reduce employment in Japan, it is worth to be concerned on what information services can be standardized and packaged as cloud computing services, and what fraction among them is provided from overseas in order to estimate the current and future effect on the economy.

Compared to prior studies in other countries, Amiti and Wei (2005) suggested that information services outsourcing does not have a negative effect on employment in UK. They explained that insignificant result is because there is job creation in the same industry classification that supplements job reduction due to the outsourcing. On the other hand, Falk and Wolfmayr (2008) suggest service outsourcing to low-wage countries has a significant negative effect on service employment in EU countries. However, they suggest that this effect is not significant when they focus only on “business services”. Based on the methodologies of these prior studies, this study conducted more detailed analysis on exporting countries and found some results that contradict the prior studies. Particularly, this study shows the possibility that information services outsourcing has effects on employment in the manufacturing sector, and the effect is different depending on which country the business process is outsourced.

However, there are several limitation and future challenge in this analysis. As

stated in previous sections, there are limitations on the measurement of outsourcing. Years of coverage in this analysis is from 2002 to 2006, which covers the period after the emerging popularity of offshore outsourcing and before the global financial crisis. If a comparison with analysis on and after 2007 were conducted, it would be possible to identify the difference of the effects on industrial structure before and after the financial crisis. In addition, the exploration on occupations which are affected by outsourcing should provide insightful information to understand the effect of outsourcing on industrial composition and to present policy implications.

The analysis in this chapter revealed that offshore outsourcing of information services suggests downward pressure on employment, although its effect is different across trading partners. In order to discuss the comprehensive effect of offshore outsourcing on the economy, it is necessary to analyze the effect also on productivity. If offshore outsourcing reduces employment and productivity is not affected or declined, overall effect on the economy is shrinkage. Conversely, if productivity is raised by offshore outsourcing, this productivity growth would make the output of the Japanese economy at least sustained, or lead to growth by making the industry competitive in global market. In order to find the comprehensive effect on the economy, the next chapter assesses the impact of offshore outsourcing on productivity of the Japanese economy.

Appendix 4-A

Summary of Statistics, 2002-2006

Variable	N	Mean	Standard Deviation	Min	Max
ΔEmployment	408	0.983	0.043	0.811	1.177
ΔWage	408	1.010	0.037	0.860	1.238
ΔValue added	408	1.016	0.142	0.099	1.781
ΔTraditional outsourcing	408	1.067	0.233	0.160	2.486
ΔIT investment	408	1.080	0.232	0.142	2.094
ΔInformation services outsourcing	408	1.200	0.303	0.575	2.034
To:					
ΔOECD	408	1.200	0.319	0.535	2.111
ΔNon-OECD	408	1.178	0.267	0.717	1.745
ΔChina	408	1.431	0.201	0.894	1.902
ΔIndia	408	1.301	0.576	0.587	2.528
ΔASEAN6	408	1.088	0.366	0.510	1.816
ΔU.S.	408	1.161	0.316	0.539	1.732

Appendix 4-B

Correlation Matrix, 2002-2006

	Employment	Wage	Value added	Traditional outsourcing	IT investment	Information services outsourcing	OECD	Non-OECD	China	India	ASEAN6	U.S.
Employment	1											
Wage	0.033	1										
Value added	0.048	0.058	1									
Traditional outsourcing	0.110**	-0.048	0.052	1								
IT investment	0.02	-0.099**	0.014	0.018	1							
Information services outsourcing	0.233***	0.117**	0.028	0.051	-0.120**	1						
OECD	0.200***	0.101**	0.035	0.066	-0.129***	0.988***	1					
Non-OECD	0.331***	0.095*	-0.018	0.016	-0.009	0.775***	0.675***	1				
China	0.310***	-0.115**	-0.042	0.153***	0.101**	0.522***	0.479***	0.729***	1			
India	0.309***	0.064	0	0.025	0.006	0.777***	0.692***	0.971***	0.782***	1		
ASEAN6	0.253***	0.066	-0.02	0.001	0	0.832***	0.748***	0.974***	0.708***	0.965***	1	
U.S.	0.290***	0.045	0.024	0.092*	-0.05	0.923***	0.901***	0.837***	0.772***	0.896***	0.870***	1

* p<0.10, ** p<0.05, *** p<0.01. Listwise.

5. Offshore Outsourcing of Information Services and Productivity[1]

The previous chapter assessed the impact of offshore outsourcing of information services on Japanese employment. This chapter turns to the effect on productivity, following the same framework as Chapter 4. This chapter provides an empirical assessment on the effects of information services outsourcing on Total Factor Productivity in Japan with a specific focus on trading partners and outsourced business processes. The results show that manufacturing sector gains positive effects from outsourcing to a wider range of countries than service sector. This section discusses the results in relation to outsourced business processes and productivity growth in Japan.

5.1 Introduction

As shown in Chapter 2, prior studies of empirical analysis on the effects of offshore outsourcing are relatively limited, and most of the prior studies have concentrated on the effect on employment (Amiti and Wei 2005, Falk and Wolfmayr 2008, Liu and Trefler 2008, Takagi and Tanaka 2012c). However, productivity also is assumed to be affected by offshore outsourcing because it affects the cost share of intermediate inputs and technology to utilize inputs. Only Amiti and Wei (2009) have directly analyzed this point and found that offshore outsourcing of services has a positive effect on total factor productivity (TFP) in the United States.

This study assumes that productivity would be raised by offshore outsourcing in three ways: cost effect, business process re-engineering (BPR) effect, and core-competence effect. In cost effect, outsourcing reduces the cost of intermediate input of information services. Until competitors also reduce costs and the prices of final products or services reach lower equilibrium, companies that outsource information services can benefit from

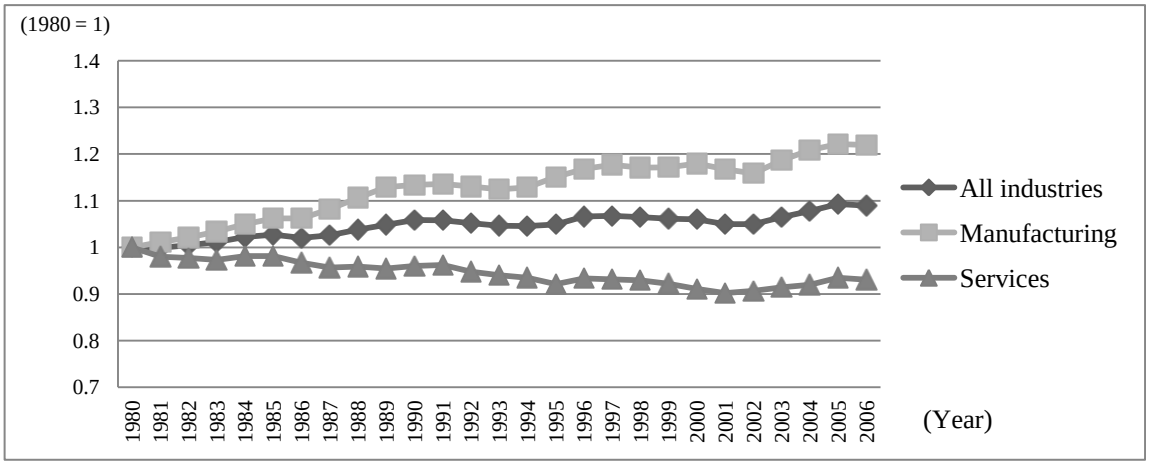
[1] This chapter is based on Takagi and Tanaka (2012a) which is restructured and revised for the dissertation.

cost reduction and achieve higher profits. Second, in the process of organizing outsourcing, the business processes which are to be outsourced are reviewed, simplified, and optimized. This BPR process also will raise productivity. Finally, companies can focus on the core-competence of organizations by outsourcing. However, this effect would take several years because of the educational and structural change of workers. If productivity is raised by offshore outsourcing, it will make the industry grow in the long term and will even support employment in the future.

Although prior studies that directly assess the effect of information services outsourcing are limited, related studies on productivity such as Motohashi (2005), Jorgenson and Motohashi (2005), Nakanishi and Inui (2008) are taken into consideration. In summary, this research is based on prior studies of offshore outsourcing and employment in terms of the field of study and also on the productivity studies in terms of the method and analytical framework.

5.2 Trend of Variables

Figure 5-1 shows the average growth of TFP excluding government services which is calculated from JIP 2009 database (RIETI 2009). The score is standardized at 1980 equals 1. TFP growth in the manufacturing sector had been stagnated since the late 1990s, but generally it has grown throughout the period. Fukao and Kwon (2006) stated that the slowdown in the 1990s was because the reallocation of resources from less efficient to more efficient firms was very slow and limited. Conversely, productivity in the service sector decreased for most of the period, except after 2002, when TFP began to increase. The trend of the volume and share of countries that export information services to Japan is the same as in Figure 4-2 and 4-3 in Chapter 4.



Source: JIP 2009 database (RIETI 2009)

Figure 5-1. TFP trend (1980 = 1)

5.3 Estimation of the Effect on TFP

This section assesses the effect of outsourcing of information services to specific countries or regions on total factor productivity in Japan. By using the amount of offshore outsourcing obtained in Chapter 4 and TFP data calculated in previous section, this section estimates the effect by panel data analysis.

5.3.1 Estimation models

Studies on productivity commonly use the output of a firm or industry as dependent variable, based on production function (Amiti and Wei 2009, Jorgenson and Motohashi 2005, Motohashi 2005). The other approach is to use TFP data that are already available as dependent variables and to assess several explanatory variables that are not used explicitly in the production function to calculate TFP. Nakanishi and Inui (2008) used this approach.

This study employs a similar approach, using TFP data as dependent variables. The estimation model is panel data analysis and described as follows:

$$\Delta TFP_{it} = \alpha + \beta_1 \Delta \frac{TDO_{it}}{Y_{it}} + \beta_2 \Delta \frac{SER_{cit}}{Y_{it}} + \beta_3 \Delta \frac{IT_{it}}{Y_{it}} + v_i + e_{it} \tag{5-1}$$

where delta represents the ratio from the previous year, TFP is total factor productivity (as indicated in the JIP database (RIETI 2009), TDO is traditional outsourcing, *SER* is information services outsourcing that is decomposed to each country and region, *c*. IT denotes information technology stock, *i* is industry sector, and *t* is year. All explanatory variables are divided by output because intermediate inputs are usually considered in the process of calculating TFP.

IT stock is also included in the analysis as an explanatory variable because potentially, IT stock may affect TFP in two channels. In the first channel, utilization of IT affects productivity directly, because software and information systems make the business process efficient. In the second channel, IT promotes outsourcing both in traditional and information services, and in this case, the outsourcing affects productivity. The exporting countries and country groups assessed in the analysis are same as in Table 4-2 in Chapter 4.

Lagged analysis is also conducted because it may take a while until outsourcing affects productivity. Cost effect and BPR effect would affect TFP in a relatively short period of time because it is usually realized at the same time as any increase in outsourcing. On the other hand, the core-competence effect would take a longer time because it may take a while for firms to arrange their organizational structures. IT stock affects TFP in relatively short period of time because business process would be optimized at the same

time as the introduction of new IT systems. Therefore, the IT stock in the explanatory variable is not lagged. The lagged model is described as follows:

$$\Delta TFP_{it} = \alpha + \beta_1 \Delta \frac{TDO_{it-1}}{Y_{it-1}} + \beta_2 \Delta \frac{SER_{cit-1}}{Y_{it-1}} + \beta_3 \Delta \frac{IT_{it}}{Y_{it}} + v_i + e_{it} \qquad (5\text{-}2)$$

Fixed-effects model is employed to estimate coefficients by the same reason as explained in section 4.4.1.[2] All data for this analysis were obtained from the JIP database (RIETI 2009) and employs 108 industry classifications. Government services are excluded from this analysis, and all variables are real value. The JIP database covers from 1970 to 2006 for most tables, but the latest five years (2002-2006) are used in the present analysis to control for the change of industrial structure. Outliers are eliminated once based on the standard, which is means plus/minus four times the standard deviations from the 1998-2006 dataset. The summary and correlations of variables are shown in Appendix 5-A and 5-B respectively. Multicollinearity is not detected in either contemporaneous or lagged model.

5.3.2 Results

Table 5-1 shows the results of estimation of the contemporaneous model. Generally, information services outsourcing has negative effects on TFP, except for outsourcing to India. In the manufacturing sector, outsourcing to non-OECD, China, and ASEAN6 countries has negative effects on TFP. In the service sector, outsourcing to non-OECD and

[2] The results of Hausman test are shown in Table 5-1 and 5-2 which is conducted with the sigmamore option using STATA/IC 11.2. Generally fixed effect model is supported for most of the specification, despite of some exception. Fixed effect model is employed throughout the analyses based on the same reason stated in section 4.4.1. Estimation with random effect model is also applied on the specification which fixed effect model is less applicable such as [1], [3], [4] of service sector in Table 5-1 and [1] and [2] of service sector in Table 5-2, but the results do not affect the following discussion.

China also have negative effects. Outsourcing to India has a positive effect only in the manufacturing sector. In the results of the lagged model in Table 5-2, information services outsourcing to most of the countries has positive effects on TFP. In the manufacturing sector, outsourcing to OECD, China, and the United States have positive effects, whereas outsourcing to ASEAN6 countries has a negative effect. In the service sector, only outsourcing to China and India have a positive effect.

In terms of IT stocks, the increase of IT stocks has a negative effect on TFP in both models in most specifications. The adjusted R-squared is higher in the contemporaneous model than in the lagged model.

Table 5-1. Results of Estimation (Contemporaneous Model), 2002-2006

	All industries				Manufacuturing				Services			
	[1]	[2]	[3]	[4]	[1]	[2]	[3]	[4]	[1]	[2]	[3]	[4]
Δ*TDO*	-0.023*	-0.023**	-0.013	-0.013	-0.021	-0.023*	-0.010	-0.011	-0.022	-0.018	-0.012	-0.012
	(0.012)	(0.011)	(0.009)	(0.009)	(0.014)	(0.013)	(0.009)	(0.009)	(0.018)	(0.017)	(0.013)	(0.013)
ΔIT Stock	-0.189***	-0.168***	-0.177***	-0.175***	-0.203***	-0.173***	-0.185***	-0.181***	-0.121*	-0.124**	-0.140**	-0.140**
	(0.038)	(0.035)	(0.033)	(0.034)	(0.042)	(0.045)	(0.037)	(0.038)	(0.070)	(0.060)	(0.057)	(0.056)
Δ*SER*	-0.030***				-0.028***				-0.027***			
To:	(0.007)				(0.010)				(0.009)			
OECD		-0.012	-0.013**			-0.012	-0.011			0.001	-0.006	
		(0.008)	(0.006)			(0.011)	(0.010)			(0.013)	(0.011)	
Non-OECD		-0.036***				-0.034***				-0.049***		
		(0.008)				(0.011)				(0.016)		
China			-0.085***	-0.081***			-0.090***	-0.088***			-0.073***	-0.072***
			(0.011)	(0.011)			(0.010)	(0.012)			(0.014)	(0.013)
India			0.060***	0.067***			0.099***	0.105***			-0.006	-0.003
			(0.014)	(0.016)			(0.010)	(0.015)			(0.020)	(0.026)
ASEAN6			-0.071***	-0.082***			-0.127***	-0.136***			0.012	0.006
			(0.018)	(0.020)			(0.014)	(0.018)			(0.025)	(0.029)
U.S.				-0.014				-0.010				-0.004
				(0.010)				(0.015)				(0.019)
constant	1.263***	1.263***	1.341***	1.337***	1.277***	1.270***	1.365***	1.359***	1.186***	1.210***	1.268***	1.266***
	(0.043)	(0.039)	(0.039)	(0.039)	(0.059)	(0.056)	(0.049)	(0.049)	(0.065)	(0.057)	(0.054)	(0.054)
N	407	407	407	407	243	243	243	243	134	134	134	134
R2(Within)	0.208	0.320	0.478	0.474	0.209	0.341	0.612	0.609	0.174	0.277	0.364	0.363
Adjusted R2	0.410	0.492	0.607	0.605	0.462	0.549	0.732	0.730	0.370	0.443	0.500	0.499
Hausman test	46.73	34.42	16.93	18.41	68.55	30.57	15.08	16.15	5.19	9.25	8.08	8.30
χ^2 (p)	(0.0000)	(0.0000)	(0.0095)	(0.0053)	(0.0000)	(0.0000)	(0.0197)	(0.0130)	(0.1586)	(0.0552)	(0.2324)	(0.2169)

Note. Robust standard errors in parentheses. * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$. Adjusted R-squared are calculated by least-squares dummy-variables regression. The number of "All industries" does not match the sum of manufacturing and services because "All industries" includes other industries such as primary industries and nonclassified industry.

Table 5-2. Results of Estimation (Lagged Model), 2002-2006

	All industries				Manufacuturing				Services			
	[1]	[2]	[3]	[4]	[1]	[2]	[3]	[4]	[1]	[2]	[3]	[4]
Δ*TDO*	0.020**	0.018**	0.014*	0.015*	0.012	0.011	0.004	0.004	0.033***	0.032***	0.026***	0.026***
	(0.009)	(0.009)	(0.008)	(0.008)	(0.013)	(0.013)	(0.013)	(0.013)	(0.010)	(0.010)	(0.009)	(0.009)
ΔIT Stock	-0.167***	-0.173***	-0.193***	-0.192***	-0.169***	-0.186***	-0.227***	-0.229***	-0.095	-0.089	-0.083	-0.083
	(0.036)	(0.039)	(0.041)	(0.041)	(0.036)	(0.043)	(0.048)	(0.049)	(0.067)	(0.065)	(0.057)	(0.057)
Δ*SER*	0.015***				0.023***				0.007			
To:	(0.005)				(0.007)				(0.007)			
OECD		0.019***	-0.002			0.028***	0.027**			0.004	0.007	
		(0.007)	(0.008)			(0.009)	(0.012)			(0.010)	(0.010)	
Non-OECD		-0.011				-0.023				0.019		
		(0.020)				(0.026)				(0.033)		
China			0.029***	0.032***			0.031**	0.017			0.054**	0.049**
			(0.008)	(0.011)			(0.014)	(0.015)			(0.025)	(0.022)
India			-0.017***	-0.017***			0.008	0.005			0.026**	0.025**
			(0.004)	(0.004)			(0.007)	(0.006)			(0.010)	(0.009)
ASEAN6			-0.022	-0.022			-0.046*	-0.036*			-0.019	-0.016
			(0.014)	(0.014)			(0.025)	(0.021)			(0.031)	(0.027)
U.S.				-0.005				0.039**				0.012
				(0.013)				(0.017)				(0.014)
constant	1.144***	1.158***	1.199***	1.198***	1.149***	1.187***	1.209***	1.214***	1.062***	1.041***	0.973***	0.975***
	(0.036)	(0.048)	(0.048)	(0.048)	(0.037)	(0.054)	(0.052)	(0.053)	(0.068)	(0.073)	(0.067)	(0.066)
N	407	407	407	407	244	244	244	244	133	133	133	133
R2(Within)	0.155	0.166	0.269	0.269	0.197	0.215	0.247	0.250	0.143	0.150	0.234	0.235
Adjusted R2	0.382	0.388	0.460	0.460	0.473	0.482	0.498	0.500	0.335	0.334	0.388	0.389
Hausman test χ^2 (p)	23.88 (0.0000)	34.53 (0.0000)	31.13 (0.0000)	31.68 (0.0000)	50.57 (0.0000)	40.35 (0.0000)	60.64 (0.0000)	59.73 (0.0000)	2.08 (0.5560)	4.86 (0.3025)	11.84 (0.0656)	11.68 (0.0695)

Note. Robust standard errors in parentheses. * p < 0.10; ** p < 0.05; *** p < 0.01. Adjusted R-squared are calculated by least-squares dummy-variables regression. The number of "All industries" does not match the sum of manufacturing and services because "All industries" includes other industries such as primary industries and nonclassified industry.

5.4 Discussion

Focusing on the change in the results from the contemporaneous model to the lagged model, several features should be pointed out. First, generally the effect of outsourcing to developing countries turns from negative to non-significant. This indicates that outsourcing to developing countries tends to lower TFP in the first year, but this negative effect disappears in the next year. As stated earlier, the cost effect and the BPR effect are assumed to be realized in a short period of time, but this result shows that any hypothesized effect is not yet realized in the first year. Conversely, the initial cost to arrange outsourcing would have increased the cost share of intermediate inputs, thus lowering TFP. However, in the next year, the cost effect or the BPR effect would compensate the initial cost and the total effect becomes neutral.

Specifically among countries that provide information services, outsourcing to China suggests the clearest effect from negative in the contemporaneous model to positive in the lagged model. Because positive effect on employment by outsourcing to China is also pointed out in Chapter 4, the benefit of outsourcing to China from Japan is notable in terms of Japanese employment and productivity. This beneficial relationship might be because of the geographical and lingual proximity as discussed in section 4.1.

On the other hand, the effects of outsourcing to other Asian countries are complicated and not clear. Outsourcing to India is positive in all industries and manufacturing in contemporaneous model, but it turns to negative in all industries and positive in service sector in the lagged model. As the amount of offshore outsourcing of information services to India is limited, the effect on India needs continuous assessment to draw implications.

Outsourcing to ASEAN6 countries causes negative effects in all industries and manufacturing sector in the contemporaneous model, but these negative effects turn less

significant, showing negative effect only in manufacturing sector in the lagged model. In general, initial negative effect on TFP is mitigated with time.

As also seen in Chapter 4, it is confirmed that the effect of offshore outsourcing to Asian countries is not homogenous but rather diverse across countries. Discussing in the lagged model, outsourcing to China suggests the most positive effect both on employment and productivity. On the other hand, outsourcing to ASEAN6 shows the negative effects both on employment and productivity. Outsourcing to India suggests more complicated effect. It reduces employment but the effect on productivity depends on the affected industry. Outsourcing to the United States also changes from non-significant to positive but only in the manufacturing sector. The United States is assumed to provide R&D or cloud computing, therefore, outsourcing of these services would have increased TFP in the manufacturing sector.

In terms of the difference between the manufacturing and service sectors, the manufacturing sector gains positive effects from outsourcing to a wider range of countries. In particular, the manufacturing sector also benefits from outsourcing to high-cost countries such as OECD and the United States. On the other hand, the service sector benefits only from outsourcing to China or India. It is thus possible to infer that the manufacturing sector would take advantage of importing services such as R&D or cloud computing from developed countries.

As pointed out by Jones and Yoon (2008), productivity of the service sector in Japan is far lower than in its manufacturing sector. They argued that this situation is a consequence of the lower levels of competition that result from regulation and less inward FDI in the service sector. As stated earlier, Fukao and Kwon (2006) pointed out that reallocation of resources from less efficient to more efficient firms was very slow and limited in the service sector. These characteristics also might be the reason for less positive

effect of information services outsourcing in the service sector. On the other hand, Minetaki and Nishimura (2010) suggest that outsourcing has a negative impact on the total factor productivity of information services firms in 1990s. However, they mainly discuss domestic outsourcing and assess contemporaneous effect. Although there are differences in scope and methodology between Minetaki and Nishimura (2010) and this dissertation, it is inferred that utilization of IT would affect the economy differently depending on its use on organizational arrangement.

Previous chapter showed that offshore outsourcing of information services reduces employment in the manufacturing sector in Japan. Increased TFP and reduced employment might be two sides of the same coin. Therefore, in terms of implications for economic policy, the government should carefully examine how liquidity of resource reallocation affects employment and TFP. The government also might need to construct statistics to track more comprehensively the volume of outsourcing specifying trading partners and the objects of trade. Cooperation across countries and global institutions also is desired to obtain more precise statistics and consider policy measures.

5.5 Conclusion

This chapter provides statistical results on the effect of offshore outsourcing on productivity in Japan with a specific focus on trading partners. As introduced in Chapter 2 on literature review, empirical analyses on the effect of information services outsourcing on productivity is scarce globally. This chapter provides a foundation for future comparative analyses between the U.S., Europe, and Japan.

The results show that the manufacturing sector gains positive effects from outsourcing to high-cost countries such as OECD and the United States as well as the outsourcing to China. On the other hand, the service sector benefits only from outsourcing

to China and India. Based on assumptions on the relation between trading partners and outsourced business processes, manufacturing sector would take advantage of importing services such as R&D and cloud computing from developed countries. In terms of productivity of the economy, the service sector is becoming larger component of the economy and the ways to increase productivity in the service sector is one of the major challenges particularly in developed countries. This chapter showed that international trade is affecting productivity not only in the manufacturing sector but also in the services sector.

Discussion in Chapter 3 on organizational view suggests that cloud computing is easier to outsource to overseas, because of the low level of transaction cost. Therefore, the effect on productivity can be quick and large. However, despite the effect on productivity is positive, it is worth to note that the effect on employment is negative as shown in Chapter 4. Therefore, empirical results in Chapter 4 and 5 suggest that employment and productivity can be inverse relation to each other, typically offshore outsourcing increases productivity while reduces employment. As seen in Appendix 4-A, value added of the Japanese economy as a whole from 2002 to 2006 shows a modest growth of annual 1.6%. Therefore, it is inferred that offshore outsourcing is not enabling the excessive growth of output, but rather raising productivity while reducing employment. The empirical analysis on the impact on output through the change in employment and productivity is one of the future challenges of this analysis. On the other hand, the relations among output, employment, and productivity are explored from a different angle in the next chapter of this dissertation, using DSGE analysis.

Several limitations and future challenges are associated with this analysis. In addition to the measurement issues that are mentioned in Chapter 4, other variables such as regulation and R&D also might contribute to the explanations of TFP variations. As mentioned in Chapter 4, comparison with the analysis on after 2007 would identify the

difference of the effects on industrial structure before and after the financial crisis, if the data is fully available. Comparative analyses with the U.S., Europe, or Asian countries and firm-based analysis also would be also future challenges.

Chapter 4 and 5 empirically assessed the effect of offshore outsourcing on employment and productivity in 2002-2006. During this period, cloud computing has emerged and it is acquiring popularity as a mean of delivering information services. The next chapter specifically focuses on cloud computing, assessing the effect on the economy by the different analytical methodology, a simulation based on DSGE model.

Appendix 5-A

Summary of Statistics

Variable	Observations	Mean	Standard Deviations	Min	Max
Δ*TFP*	407	1.010	0.044	0.876	1.187
Δ*TDO*	407	1.061	0.232	0.175	2.522
ΔIT Stock	407	1.019	0.093	0.799	1.361
Δ*SER*	407	1.194	0.306	0.566	2.067
OECD	407	1.200	0.367	0.513	3.089
Non-OECD	407	1.181	0.331	0.586	3.387
China	407	1.432	0.295	0.720	3.506
India	407	1.307	0.630	0.563	4.906
ASEAN6	407	1.094	0.416	0.488	3.524
U.S.	407	1.162	0.367	0.517	3.362

Appendix 5-B

Correlations of Variables

	Δ*TFP*	Δ*TDO*	ΔIT Stock	Δ*SER*	OECD	Non-OECD	China	India	ASEAN6	U.S.
Δ*TFP*	1									
Δ*TDO*	-0.145***	1								
ΔIT Stock	-0.368***	0.062	1							
Δ*SER*	-0.260***	0.077	-0.076	1						
OECD	-0.406***	0.117**	-0.034	0.922***	1					
Non-OECD	-0.489***	0.075	0.115**	0.712***	0.767***	1				
China	-0.592***	0.167***	0.127**	0.473***	0.649***	0.833***	1			
India	-0.347***	0.067	0.052	0.751***	0.744***	0.952***	0.771***	1		
ASEAN6	-0.406***	0.063	0.039	0.796***	0.805***	0.973***	0.772***	0.965***	1	
U.S.	-0.425***	0.131***	0.011	0.854***	0.925***	0.883***	0.822***	0.909***	0.900***	1

Note. Robust standard errors in parentheses. * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

6. Macroeconomic Analysis of Cloud Computing based on the Organizational View[1]

This chapter turns to the "present" stage of the organizational change, which is the adoption of cloud computing. Cloud computing is becoming one of the major technological changes for business management in the last decade. However, despite of the concern on the impact on business and the economy, its effect is still not known well. This study constructs a macroeconomic model that incorporates the diffusion of cloud computing identifying three paths by which cloud computing affect the economy: productivity, entry cost, and sales in information services sector. The results of the impulse response analysis show that the overall effect on the economy is positive assuming the baseline growth of TFP, but negative without the baseline growth. Total effect depends on the combination of productivity growth and international trade of computing services. The implication of these results is discussed combined with the organizational view in Chapter 3 and the empirical results on offshore outsourcing in Chapter 4 and 5.

6.1 Background

Cloud computing has become one of the major topics among the information technology architecture. It provides information services from centralized data centers so that firms do not need to invest in and own huge computer resources. General consumers also benefit from cloud computing such as services by *Google* or *Dropbox*. However, business sector also started to use cloud computing for various business services such as the information services for email, human resource management, supply chain management, customer relationship management. For example, *Salesforce.com* provides a wide range of services such as Customer Relationship Management (CRM)[2]. *Amazon Web Services* also provides

[1] This chapter is based on Takagi and Tanaka (Forthcoming) which is restructured and revised for this dissertation.
[2] Based on the description at http://www.salesforce.com/products/. Accessed July 4, 2014.

a wide range of services such as platforms so that customers can create and provide services on the platform[3].

In terms of the scope of users, cloud computing is categorized to public, private, and hybrid. Public cloud computing is shared by anonymous users globally, and private cloud computing is used by specific user firms or organizations. Hybrid combines public and private. The present study focuses on the aspect of cloud computing such as specialization, outsourcing, and scale benefit, therefore, this study focuses on public cloud computing as the object of the study.

These new types of services are penetrating rapidly in the Japanese economy. IPA (2012) shows that the experience of using SaaS (Software as a Service, one of the service models of cloud computing) has grown from 19.5% in 2010 to 33.7% in 2011. The major benefit of cloud computing for customers is the cost reduction, because firms can share the resources with many other customers. Firms can also enjoy the flexibility because they can use the computing resources as much as they need without building their own capacity. Because cloud computing is expected to reduce the cost for firms to utilize information technology drastically, it is expected to promote economic growth when wider range of firms can benefit from IT. On the other hand, cloud computing may be provided from anywhere in the world. If the domestic cloud provider is not competitive, the Japanese economy may face the hollowing-out effect particularly in information services sector. Therefore, cloud computing has two-sided potential effects of both of the growth and the challenge.

A certain amount of articles have been published on cloud computing, but the concerns and academic disciplines are scattered across literatures as shown in Chapter 2. For example, some studies focus on technological architecture, and others discuss on

[3] Based on the description at http://aws.amazon.com/. Accessed July 4, 2014.

security and privacy. Some studies argue market governance such as competition law and regulation. Despite of the potential impact on business and the economy, its effect on the economy is not studied enough.

From macroeconomic point of view, analysis with the models with micro-foundation such as dynamic stochastic general equilibrium (DSGE) model or its foundation, real business cycle (RBC) model is becoming popular among literatures. However, its application is heavily concentrated on financial and monetary policy. DSGE analysis on the specific technological innovation and macroeconomic variables is still yet fully utilized.

Therefore, this study tries to construct a model to understand the impact of the diffusion of cloud computing in macroeconomic scale. It reports the results of impulse response analysis on macroeconomic variables when the economy encounter the diffusion of cloud computing. The model would be a prototype for further development, but it builds a foundation for analysis on a specific technological innovation and its macroeconomic implication.

6.2 Models

The main purpose of this Chapter is to implement the impact of cloud computing into macroeconomic models. The base model in which the cloud computing is incorporated is the conventional RBC model with monopolistic competition (Griffoli 2011). The base model follows Griffoli (2011) which describes the behavior of household and firms.[4]

[4] This analysis used the model of Griffoli (2011) to focus on the extensibility and generality of the model. However, the use of the model which is specifically used for the analysis on Japan such as Hayashi and Prescott (2002) is one of the future options.

6.2.1 Base model[5]

Representative household follows the utility function:

$$E_t \sum_{t=0}^{\infty} \beta [logC_t + \psi \log (1 - l_t)] \tag{6-1}$$

where C is consumption, l is a unit of labor therefore 1-l means the time used for leisure. Household maximize the equation (6-1) under the following budget constraint:

$$c_t + k_{t+1} = w_t l_t + r_t k_t + (1 - \delta) k_t \tag{6-2}$$

where k is capital, w is wage, r is interest rate, δ is depreciation rate of capital. $w_t l_t + r_t k_t = y_t$, where y is output under the perfect competition. Note that:

$$i_t = k_{t+1} - (1 - \delta) k_t \tag{6-3}$$

where i represent the flow of investment. Therefore,

$$i_t = y_t - c_t \tag{6-4}$$

From first order condition of (6-1) under budget constraint (6-2), Euler equation for consumption is obtained as:

$$\frac{1}{c_t} = \beta E_t \left[\frac{1}{c_{t+1}} (1 + r_{t+1} - \delta) \right] \tag{6-5}$$

[5] Symbols in the base model are E:expectation, β:discount, ψ:consumption, δ:depreciation, c:consumption, l:labor, k:capital, w:wage, r:interest, y:output, i:investment flow, e^{z_t}:productivity.

and first order condition for *w* is:

$$\psi \frac{c_t}{1-l_t} = w_t \tag{6-6}$$

In terms of the firm section, each firm *i* produces output following Cobb-Douglas function with Harrod-Neutral technological progress:

$$y_{it} = k_{it}^{\alpha}(e^{z_t} l_{it})^{1-\alpha} \tag{6-7}$$

where *z* is the level of technology. Profit of firm is described as follows:

$$k_{it}^{\alpha}(e^{z_t} l_{it})^{1-\alpha} - w_t l_t - r_t k_t \tag{6-8}$$

Optimal capital labor ratio is obtained from first order condition for *k* and *l*:

$$\text{k:}\ \ \alpha k_{it}^{\alpha-1}(e^{z_t} l_{it})^{1-\alpha} = r_t \tag{6-9}$$

$$\text{l:}\ \ k_{it}^{\alpha}(1-\alpha)(e^{z_t} l_{it})^{-\alpha} = w_t \tag{6-10}$$

Dividing (6-9) by (6-10) yields optimal capital to labor ratio:

$$k_{it} r_t = \frac{\alpha}{1-\alpha} w_t l_{it} \tag{6-11}$$

Under the monopolistic competition, price is determined by:

$$p_{it} = \frac{\epsilon}{\epsilon-1} mc_t p_t \tag{6-12}$$

where $p_{it}$is firm-specific price, mc_t is marginal cost, and $\epsilon$is the elasticity of substitution. For simplification, individual firms take market price p_t, therefore $mc_t = \frac{\epsilon-1}{\epsilon}$. Combining the marginal cost and the production function, the following conditions are obtained:

$$w_t = (1-\alpha)\frac{y_{it}}{l_{it}}\frac{(\epsilon-1)}{\epsilon} \tag{6-13}$$

$$r_t = \alpha\frac{y_{it}}{k_{it}}\frac{(\epsilon-1)}{\epsilon} \tag{6-14}$$

6.2.2 Implementing Cloud computing

In this study, three paths are identified and incorporated into the base model. Before going into the identification of paths, the diffusion of cloud computing is defined. According to IDC (2012), the share of cloud computing is estimated to be 20% (1$ out of 5$ spent on software) in 2016. The present study assumes that the origin of commercial cloud computing is around 2000, considering *Salesforce.com* started its business in 1999[6]. By taking the assumption that it takes 16 years for cloud computing to grow its share to 20%[7], and that marginal diffusion decreases over time, the additional diffusion of cloud computing is defined as follows:

[6] http://www.salesforce.com/company/#1999 (Accessed on April 2, 2013)

[7] This assumption does not suggest that the diffusion rate of cloud computing in Japan necessarily reach 20% in 16 years, but rather define the diffusion path shown in Figure 6-1, based on a prior study. As the characteristics of DSGE analysis, it is possible to make an analysis at whatever diffusion rate, along with the diffusion paths. Ukai (2013) shows that 10% of Japanese firms which is listed on Tokyo Stock Exchange use pure public cloud computing from 2012 to 2013.

$$cloud_t = \omega cloud_{t-1} + ecloud, \quad 0 < cloud_t < 1 \tag{6-15}$$

where $ecloud$ is white noise with zero means and normal distribution, and in this context, it is the temporary shock to start the diffusion. $cloud_t$ is defined as additional penetration rate of cloud computing which is $0 < cloud_t < 1$. The diffusion speed follows the process of auto regressive one (AR(1)) with ω=0.95. To fulfill the assumption that the diffusion reaches 20% in 16 years, $ecloud$ is set to 0.018. Based on (6-15), cumulative diffusion of cloud computing is defined as follows:

$$cum\_cloud_t = \omega_2 cum\_cloud_{t-1} + cloud, \quad 0 < cum\_cloud_t < 1 \tag{6-16}$$

where ω_2=0.999. As a result, the diffusion of cloud computing follows the path as shown in Figure 6-1.

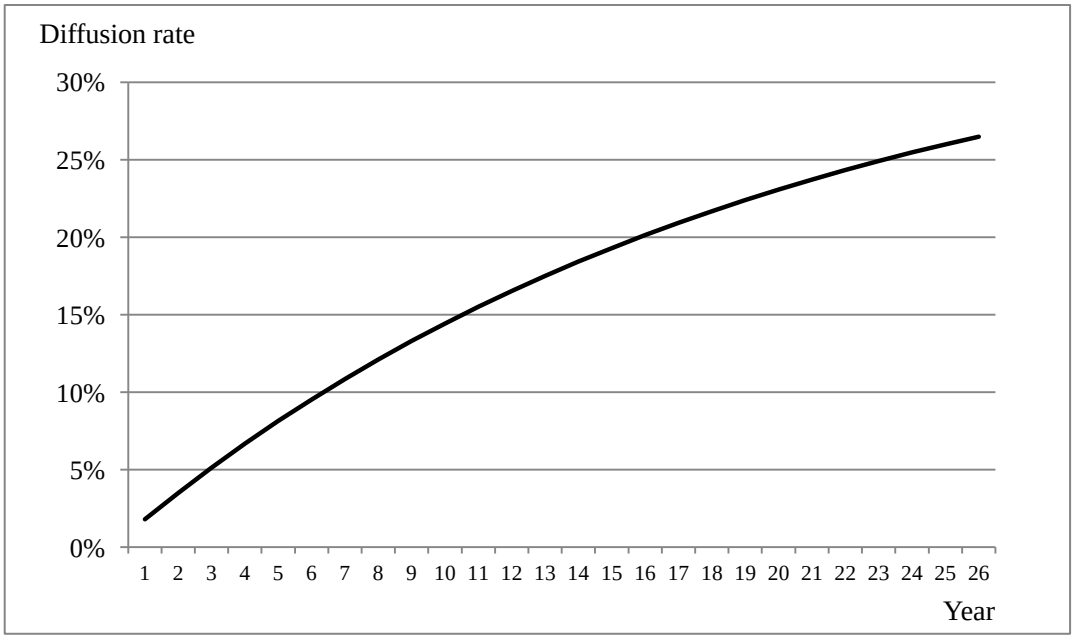


Figure 6-1. Diffusion path of cloud computing

In this analysis, it is assumed that cloud computing affects the economy through three paths: First, cloud computing increases productivity of firms. Because cloud computing reduces the deployment cost of IT, more firms can enjoy the benefit of IT. Positive effect of IT on productivity has been reported by a significant amount of studies such as Jorgenson (2002), Jorgenson and Motohashi (2005), Miyazaki et al. (2012). Overall productivity is supposed to be improved with the reduction of deployment cost of IT. This effect through productivity is discussed more in detail in section 6.2.3.

Second, as seen in prior studies, cloud computing can lower entry cost for new firms thus increase the number of new firms. Etro (2009) focuses on this effect and develops the model that depends specifically on the entry cost and the number of firms. Based on this increase in the number of firms, the present study assumes that the increased number of firms can intensify the competition among firms, and promote innovation. Newly developed SMEs also can promote innovation and transfer of employment from less productive to more productive sector. Therefore, this study assumes that the increased number of firms can raise the productivity of the economy.

Thirdly, cloud computing can reduce the output of domestic information services industry by intensified international competition. The key characteristics of cloud computing is sharing the computing resources among users. The value of service increases as more customers use the same resources, and wider range of services is provided. As discussed in the analysis by transaction cost economics in chapter 3, cloud computing requires less proximity to customers, therefore these network effects can lead competition and monopolistic market structure in global scale. Global players such as *Microsoft*, *Salesforece*, *Amazon*, *Google* are the examples of those global players. Cloud computing tends to converge to smaller number of players in global scale than traditional IT investment, therefore, it is possible that the domestic output of information services

industry is reduced by the competition with foreign players. Besides the international competition effect, cloud computing reduces the cost for using IT drastically by sharing computing resources. This also can reduce the sales of tailor-made information systems, however, it may be offset by the increase of the demand on IT as a whole. Therefore, it is assumed that the total expenditure for information services as a whole is not affected in the analysis.

Based on these assumptions, these three effects are incorporated in the base model as follows. Productivity level z_t is determined by the level of previous year and the diffusion of cloud computing, $cloud_t$ and the number of firms, n_t:

$$z_t = \rho z_{t-1} + \phi cloud_t + \tau n_t \tag{6-17}$$

where ρ, ϕ and τ are parameters that are calibrated in the next section.

Entry cost η_t is defined as the change ratio from steady state, and it is reduced by the diffusion of cloud computing:

$$\eta_t = \rho \eta_{t-1} - \theta cloud_t, \qquad -1 < \eta_t < 1 \tag{6-18}$$

And this entry cost can increase the number of firms through:

$$n_t = \gamma \left(n_{t-1} + \chi \frac{\upsilon i}{\eta + 1} \right) \tag{6-19}$$

where υ is the ratio of investment into new firms among total investment, i. In order to make the entry cost η as non-zero value, entry cost is expressed as $\eta + 1$. By adjusting

relative size of new firms and current number of firms by χ, $\chi\frac{vi}{\eta+1}$ represents the number of new firms. Following Etro (2009), a certain rate of business is destructed by $1-\gamma$, where γ is set as 0.97.

Finally, subtracting the negative effect of reduced revenue in information services industry from total output:

$$y_{it} = k_{it}^{\alpha}(e^{z_t}l_{it})^{1-\alpha} - \mu * cum\_cloud_t \tag{6-20}$$

Figure 6-2 shows the relations of endogenous variables. The diffusion of cloud computing affects the variables through the three paths. However, endogenous variables also affect each other. For example, number of firms (n) affects productivity (z), capital (k) affects output (y), and investment (i) affects number of firms (n). Therefore, the diffusion does not simply affect the economy by three paths but also affect through the intertwined system of variables[8].

[8] This analysis is based on stochastic model, which means all variables will return to the original steady state in the very long term (e.g. 100 years). In DSGE analysis, there are options of stochastic and deterministic model, and stochastic model assumes the shock is temporary, and deterministic model assumes that the shock is permanent. Considering the productivity effect of information technology, it is also one of the options to employ deterministic model, however, it requires to identify the new steady state values of all variables. However, the present study focuses on the impact on variables that are not known beforehand. Therefore, this study employs the stochastic model. This is one of the limits of current DSGE analysis.

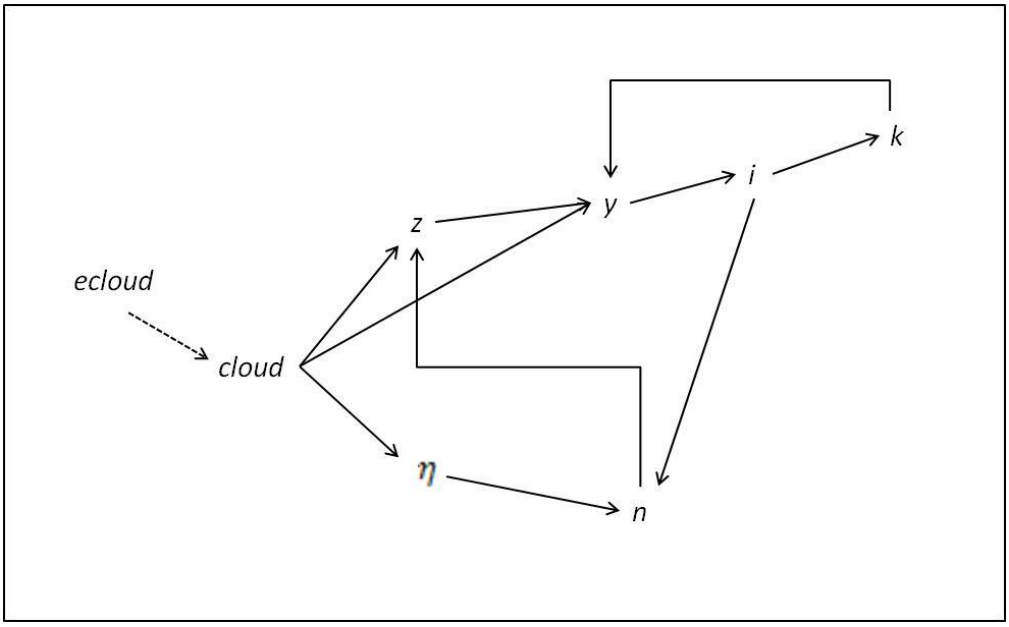


Figure 6-2. Relationship of endogenous variables

6.2.3 Calibration

In this section, parameters are categorized as structural parameters of the base model and the operational parameters which are used to define the extent of the effects of cloud computing. Structural parameters of the base model are taken by Griffoli (2011) as shown in Table 6-1[9].

Table 6-1. Calibration of structural parameters of base model

α	β	δ	ψ	ρ
0.33	0.99	0.023	1.75	0.95

One of the characteristics of the present analysis is that the estimated size of the

[9] This study employs the structural parameters of Griffoli (2011) rather than Hayashi and Prescott (2002) or Sugo and Ueda (2008) because the difference of the models would affect applicability of parameters. Incorporating parameters on Japanese economy by these studies is one of the future challenges for improving empirical foundation.

impact of the diffusion of cloud computing depends on the effects of three paths: productivity, entry cost and the number of firms, and reduced sales. The overall effect on the economy is affected by the combination of the operational parameters that define the impact of these paths. It is relatively possible to make an assumption on the effects of entry cost and reduced sales, because of the presence of prior studies and simple structure. However, the effect on productivity is not simple and it is rather controversial. Therefore, operational parameters that define the impact on entry cost and reduced sales are calibrated based on the prior studies and simple assumption, and the parameters that define the effect on productivity are calibrated based on the multiple scenarios. Generally, the calibration of operational parameters is conducted by the following procedure. First, steady state of the base model is calculated before incorporating the diffusion of cloud computing. Each parameter is calibrated so that each influence path has a reasonable impact on the initial steady state values.

The impact on entry cost is defined by θ. Etro (2009) estimated that cloud computing can lower entry cost 1% or 5% depending on the speed of diffusion. Taking the moderate estimation from Etro (2009), the present study assumes that the entry cost is lowered 1% by the diffusion of cloud computing. Etro (2009) does not specify the penetration rate of cloud computing. For convenience, this study sets the target of diffusion to reach 20% in 16 years from equation (6-15) and Figure 6-1. θ is calibrated so that entry cost (η) is reduced 1% when the cumulative diffusion of cloud computing reaches 20%. Related to the number of firms, χ adjusts the relative size of the total number of firms and newly created firms. According to JSBRI (2012), the latest available percentage of newly created firms among total number of firms is 5.1% during 2004 to 2006. χ is calibrated based on this statistics.

Reduced revenue on information services industry is defined by μ. Data on the

share of foreign cloud services among total cloud services is not available, therefore, this study assumes that the half of the services is provided by international providers. If the total spending on IT services does not change, and the diffusion of cloud computing reaches 20%, domestic information services industry reduces its output by 10%. As software and information sharing/providing industry constitutes 4.1% of GDP of Japan (MIC 2012), the relative size of the impact on total GDP also has to be adjusted. μ is calibrated to fulfill these conditions.

In terms of the effect on productivity, multiple scenarios are assumed, and calibration is conducted based on these scenarios. The growth of total factor productivity (TFP) and its relation to IT investment has been taken much attention in academic literatures, and it has been discussed by two aspects. The one is baseline growth of TFP that is observed even without IT investment, and the other is the other is the impact of IT on TFP that is observed as a contribution of IT investment on TFP growth. Takagi and Tanaka (2012a) show that the average growth rate of TFP between 2002 to 2006 in Japan was approximately 1%, based on JIP 2009 database. Jorgenson and Motohashi (2003) show that the growth of TFP was 1.13% between 1995 and 2000 including the contribution of IT investment. JSBRI (2008) shows that the average growth of labor productivity between 2000 and 2006 was 2.1%. By taking the moderate assumption, the baseline growth of TFP is assumed to be 1% annually.

However, the effect of IT on TFP is more controversial. Cloud computing promotes the utilization of IT throughout the economy because of the cost reduction effect of using IT. Therefore, the calibration is based on the studies on IT investment and productivity. As discussed in chapter 2, “productivity paradox” has been reported to note that IT investment does not lead to productivity increase since late 1980s (Solow 1987, Oliner and Sichel 1994, Steiner 1995). However, positive relation between IT investment

and productivity has been gradually reported since late 1990s, such as Brynjolfsson and Hitt (2000)[10]. In Japan, positive results are also reported, although its significance and the size of the impact are diverse across empirical settings and analyzed industrial sectors (e.g. Matsudaira 1997, Takemura 2003). For example, Motohashi (2003) shows that manufacturing companies that utilize information networks achieve 1% higher TFP growth than those without information networks. Considering a diversity in empirical results, the present study assumes the minimum positive effect on productivity, assuming that 1% increase of the diffusion of cloud computing leads to approximately 0.01% of productivity (e^z) increase, that is 20% diffusion of cloud computing leads to approximately 0.2% productivity growth. Based on these prior studies, ϕ is calibrated following the four scenarios on the productivity effect.

Scenario 1. Both of 1% baseline growth of TFP and contribution of cloud computing on TFP are included

Scenario 2. Only 1% annual growth of TFP is included but contribution of cloud computing on TFP is not included.

Scenario 3. Only the effect of cloud computing is included but the baseline growth is not included.

Scenario 4. Neither of baseline growth of TFP nor contribution of cloud computing on TFP is included.

Given the absence of empirical studies, τ, υ are set by the following assumptions. τ adjusts the relation between the number of firms and productivity. It is calibrated so that 1% increased number of firms can lead to approximately 0.01% increase of productivity. υ

[10] In terms of prior studies on IT investment and productivity, see Watanabe and Ukai (2003).

sets the ratio of investment in newly created firms among total investment, and it is set to 0.1.

In summary, operational parameters that are used to implement the diffusion of cloud computing are calibrated as Table 6-2 and Table 6-3[11].

Table 6-2. Calibration of operational parameters

θ	μ	τ	χ	υ
0.07	0.01829	0.0017	1.649	0.1

Table 6-3. Calibration of ϕ

Scenario 1	Scenario 2	Scenario 3	Scenario 4
1.205	1.195	0.0149	0

6.3 Results of Impulse Response Analysis

This section shows the results of impulse response analysis on the four scenarios and the additional analysis.

6.3.1 Results with four scenarios on the productivity effect

Impulse response analysis is conducted on the model with the 0.018 standard error shock on *ecloud* following the diffusion path in Figure 6-1. The results on *y* (output), *z* (productivity level), and *n* (number of firms) are shown in Figure 6-3. Horizontal axis is period (year), and vertical axis is the difference from steady state. Note that the movement

[11] Productivity grows under $\phi = 0$, because increased number of firms contribute TFP to rise.

of variables in percentage in the following sections refers to the ratio of difference from the steady state. As the present study sets the target of diffusion of cloud computing to reach 20% in 16th year, the change in GDP, number of firms, and productivity in the 16th year is compared in Table 6-4. The results of impulse response analysis for all variables are shown in Appendix 6-A, 6-B, 6-C, 6-D, and steady state values are shown in Appendix 6-F.

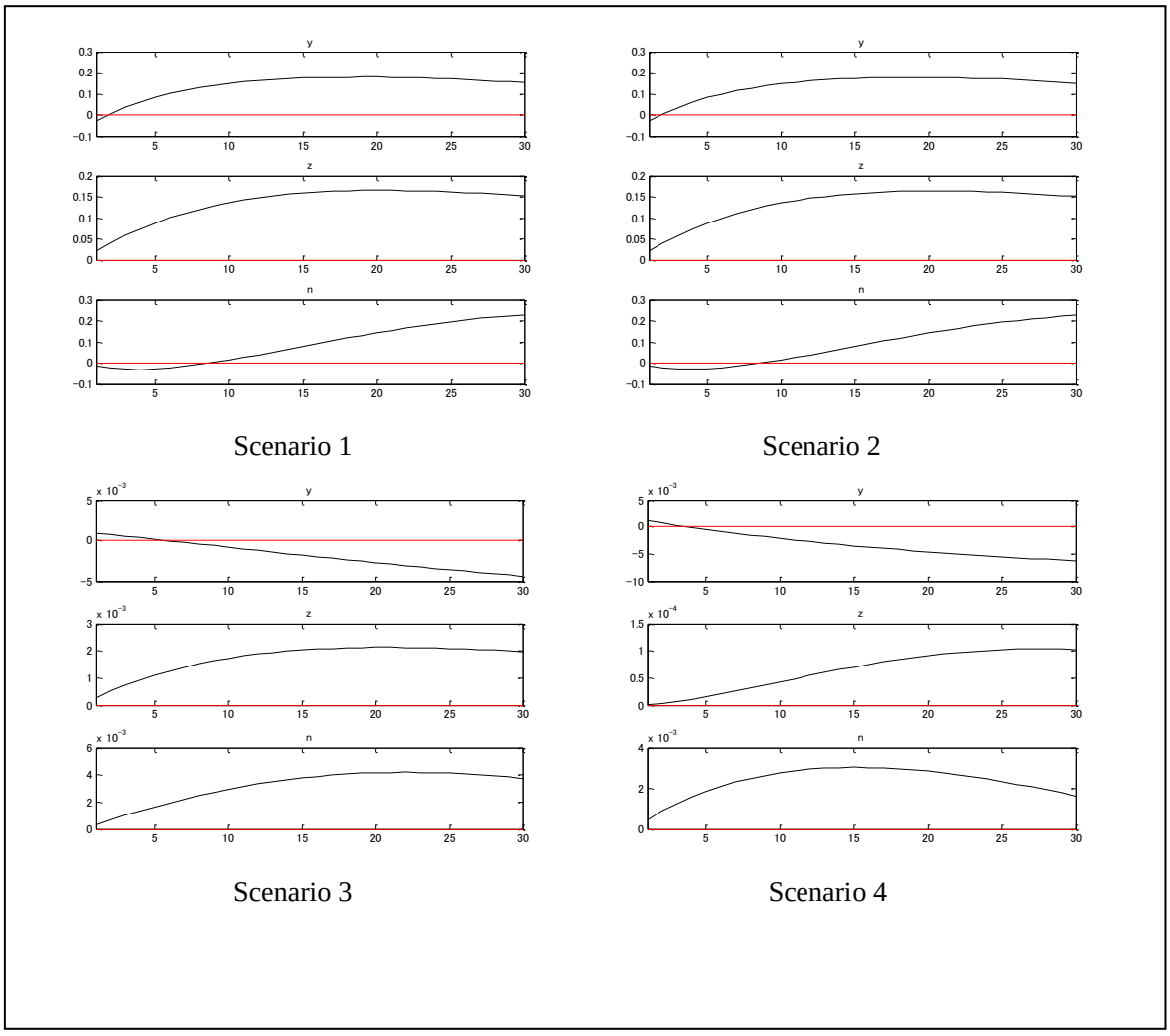


Figure 6-3. Results of the impulse response analysis on *y*, *z*, *n*

Table 6-4. Results at 20% diffusion of cloud computing

	Scenario 1 (Baseline + cloud)	Scenario 2 (Baseline)	Scenario 3 (Cloud)	Scenario 4 (None)	Difference (Scenario 1-2)	Difference (Scenario 3-4)
y (GDP)	18.781%	18.580%	-0.214%	-0.398%	0.20%	0.18%
e^z (Productivity)	17.527%	17.363%	0.207%	0.008%	0.16%	0.20%
n (number of firms)	8.954%	8.859%	0.375%	0.292%	0.09%	0.08%

Note: Difference from steady state.

As seen in Figure 6-3, impulse response analysis with scenario 1 and 2 shows that the most variables move positively responding to the diffusion of cloud computing. In terms of the effect on GDP, comparison between scenario 1 and 2 in Table 6-4 shows that 20% diffusion of cloud computing boosts GDP by 0.2%. As the GDP of Japan in fiscal year 2012 is 519.6 trillion JPY[12], 0.2% is translated as 1.04 trillion JPY per year. Without baseline growth of TFP as in scenario 3 and 4, GDP is decreased[13]. Comparing scenario 3 and 4 in Table 6-4, 20% diffusion of cloud computing mitigates the negative effect on GDP by 0.18%.

6.3.2 Analysis on the minimum requirement on TFP

In scenario 3 and 4, it is observed that total effect on GDP becomes negative. In order to explore how much productivity effect of cloud computing is required to make total effect positive without baseline growth of TFP, value of ϕ is adjusted manually. It is found that

[12] Cabinet Office. GDP statistics, http://www.esri.cao.go.jp/jp/sna/menu.html (Accessed on April 9, 2013).

[13] Initial increase of Y would be because of the increase of investment, that is led by the reduction of entry cost (eta)

ϕ is required to be at least approximately 0.04 to make overall results positive. The results of impulse response analysis with ϕ = 0.04 is shown in Appendix 6-E. In this setting, GDP grows with its peak at 9th year to reach 0.143% above its steady state.

ϕ = 0.04 means that productivity, which is expressed as e^z, becomes 0.545% above its steady state in 16th year. This is translated to 0.034% CAGR annual growth of TFP. Under this setting, the productivity increase surpasses the effect of sales reduction in IT services industry, and make the GDP positive.

6.4 Discussion

The results in the previous section show that 20% diffusion of cloud computing boosts GDP by 0.18 to 0.2%. However, without baseline growth of TFP, total effect on GDP is negative. This means that sales reduction effect is greater than other positive effects: productivity and increased number of firms. In order to achieve positive effect on the economy without baseline growth of TFP, 20% diffusion of cloud computing needs to raise productivity 0.545%. The present study assumes the minimum positive effect on productivity, assuming 20% diffusion of cloud computing leads to 0.2% productivity growth. Given one of the prior studies suggests that firms with information networks achieve 1% higher TFP (Jorgenson and Motohashi 2003), the gap between 0.545% and 0.2% is not too large. However, it is still not certain whether it is possible for cloud computing to raise productivity 0.545%.

On the other hand, the negative effect is assumed to be caused by the reduction of sales in information services industry. The present study assumes that the total spending on IT services does not change. However, total spending has continued to grow. Based on data of MIC (2012), the growth rate of market size of information services sector is calculated. The result shows that during 2000 to 2010, information services sector has grown by

CAGR 4.9%. If this growth continues, the negative effect of reduced sales due to the competition with international cloud provider would be mitigated. Additionally, from the practical point of view, negative effect might be overcome by the baseline growth of TFP as shown in scenario 1 and 2.

Compared to the prior studies by Etro (2009, 2011), which shows that GDP will grow 0.05% to 0.3% as in Table 2-3, the results of the present study suggest that the overall effect heavily depends on the assumption of the impact on each paths. The present study suggests the more positive effect on GDP with the baseline growth of TFP, and more negative effect without baseline growth. It reflects the difference of the model, as the studies of Etro (2009, 2011) specifically depend on the business creation and its positive effect, whereas the present study includes multiple paths that include both of positive and negative effect.

6.5 Conclusion

This chapter constructs a model to analyze the economic impact of cloud computing. It identifies three paths for cloud computing to affect macroeconomic variables and incorporates them into standard DSGE framework. Given the practical concern and the scarcity of the prior studies in the field, this chapter fills in the missing part in prior studies. Compared to prior studies by Etro (2009, 2011), the present study proposes more simplified but comprehensive way to understand the effect of the evolution of information technology on the economy.

The results show that 20% diffusion of cloud computing boosts GDP by 0.18 to 0.2%. However, without baseline growth of TFP, total effect on GDP is negative. The possibility to overcome the negative effect is argued such as more positive effect of cloud computing on productivity, the growth of information services market, and the baseline

growth of TFP. From the viewpoints of economic policy, it is important to ensure that the additional use of information technology contributes to the rise of productivity. However, as the analyses in chapter 4 and 5 showed, positive relationship between employment and productivity is questioned at least as the result of offshore outsourcing. One of the reasons of positive relation between productivity and employment in DSGE analysis in this chapter may be that demand is not fully constrained. If the demand is already fulfilled while productivity rises, the result may be the reduction of inputs. From the practical view, it is important to secure employment while raising productivity by the use of information technology.

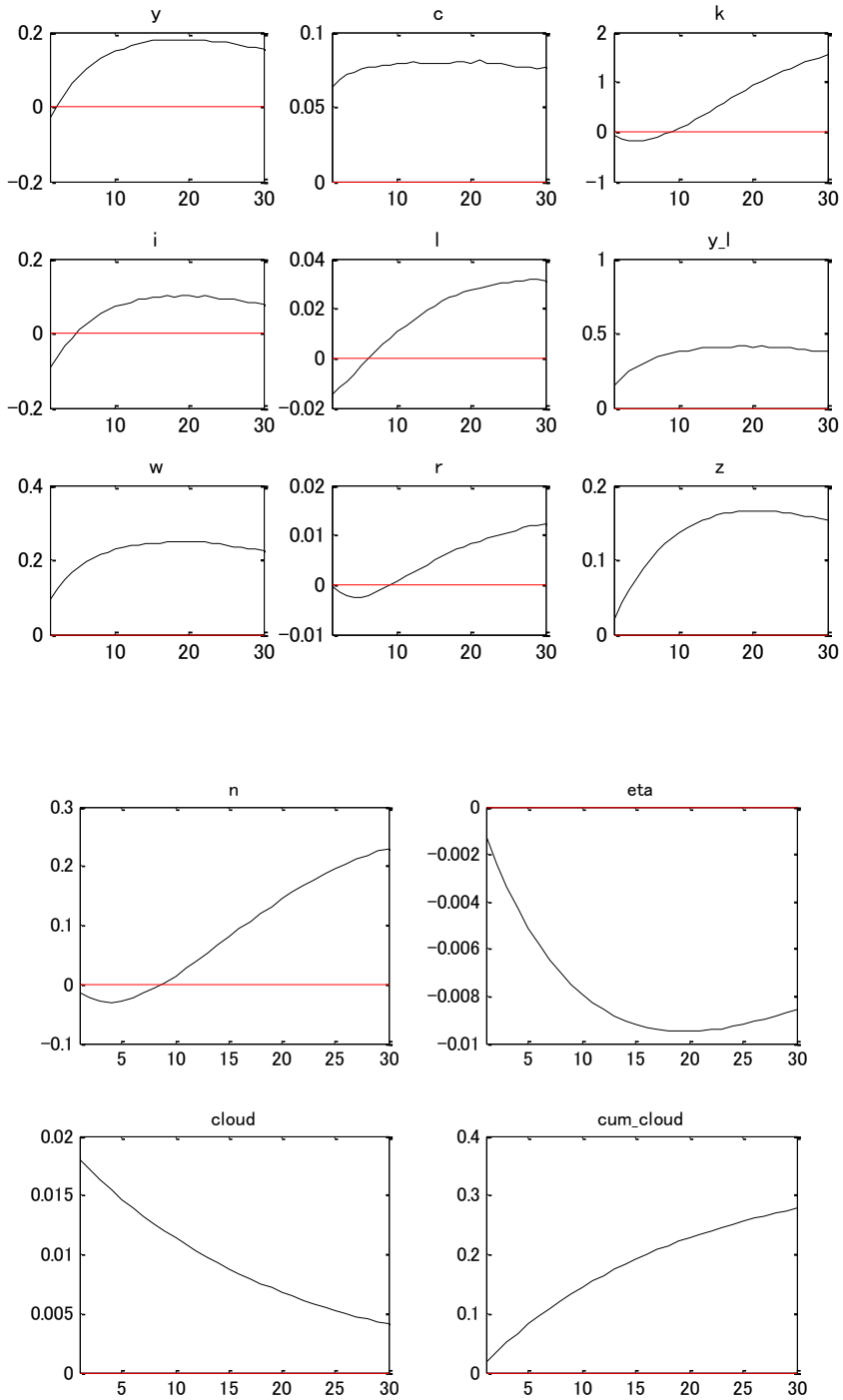
Discussion in chapter 3 suggests that cloud computing is relatively easier to outsource to overseas because of the low transaction cost. Because the outsourcing of information services could be more promoted if the services are packaged as cloud computing service, it is important to check the development of the contents of services of cloud computing services globally, and the effects on the economy.

This study contains several challenges for further improvement. First, the model is simple and straightforward, but the size of the impact depends on the calibration of parameters. The calibration is better to be based on the more coverage of the empirical foundations on such as cloud computing and entrepreneurship, and cloud computing and the revenue of information services sector. Alternatively, it would be possible to construct a model in which the variables are determined endogenously and the size of the effects does not depend on calibration. This chapter provides the first step to understand the technological change and its implication on macroeconomic variables, and it is ready for further improvement.

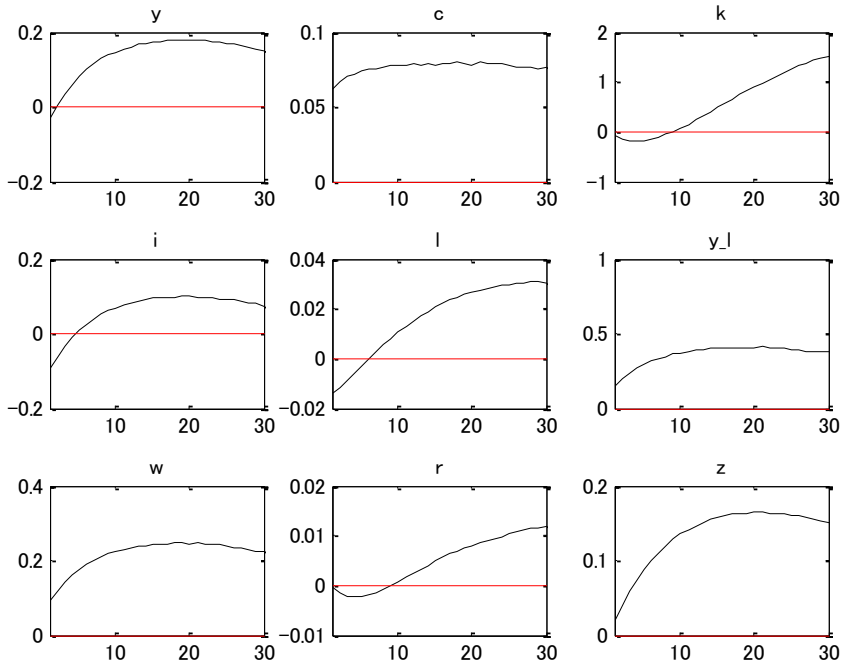
Based on the organizational view in chapter 3, quantitative analyses on the impact of organizational change as the forms of offshore outsourcing and cloud computing are

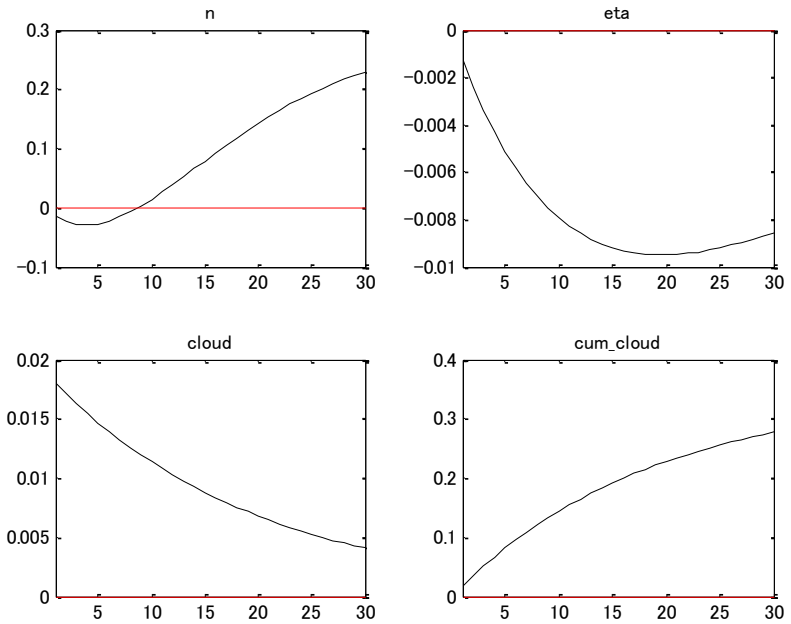
conducted in chapter 4, 5, and 6. The final chapter draws overall implications from these analyses, considering the prospects on the future development of productive organizations.

Appendix 6-A. Impulse response analysis (Scenario 1)

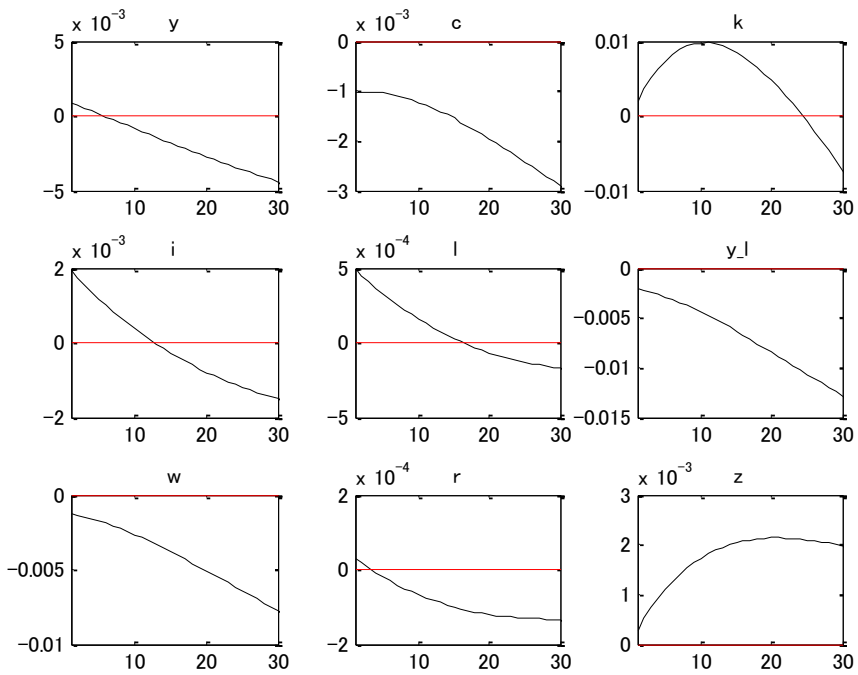


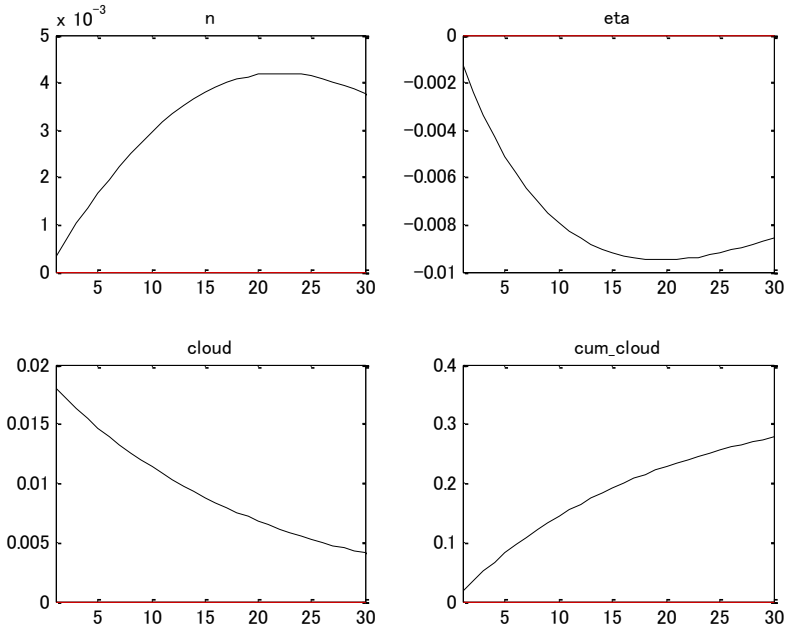
Appendix 6-B. Impulse response analysis (Scenario 2)



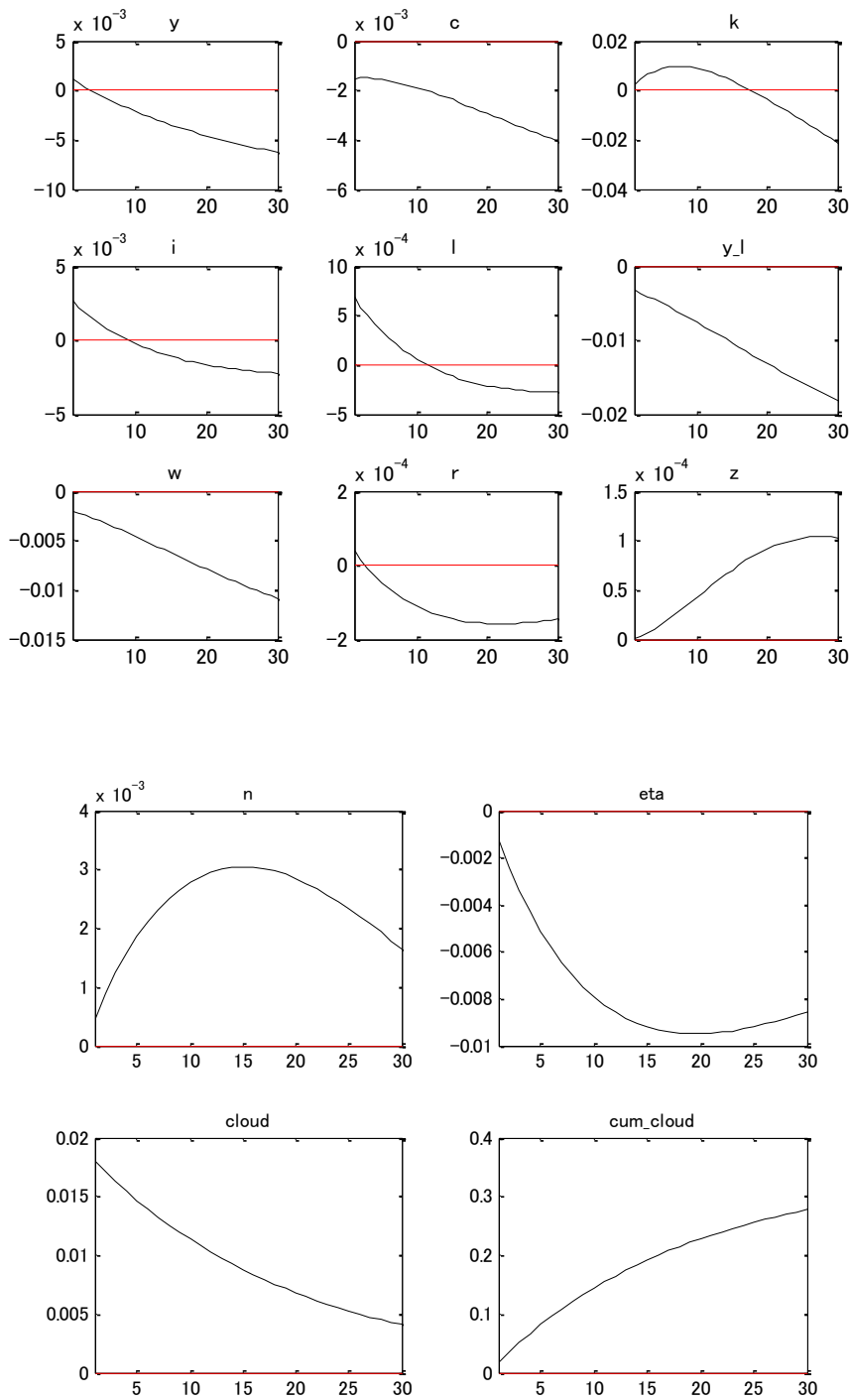


Appendix 6-C. Impulse response analysis (Scenario 3)

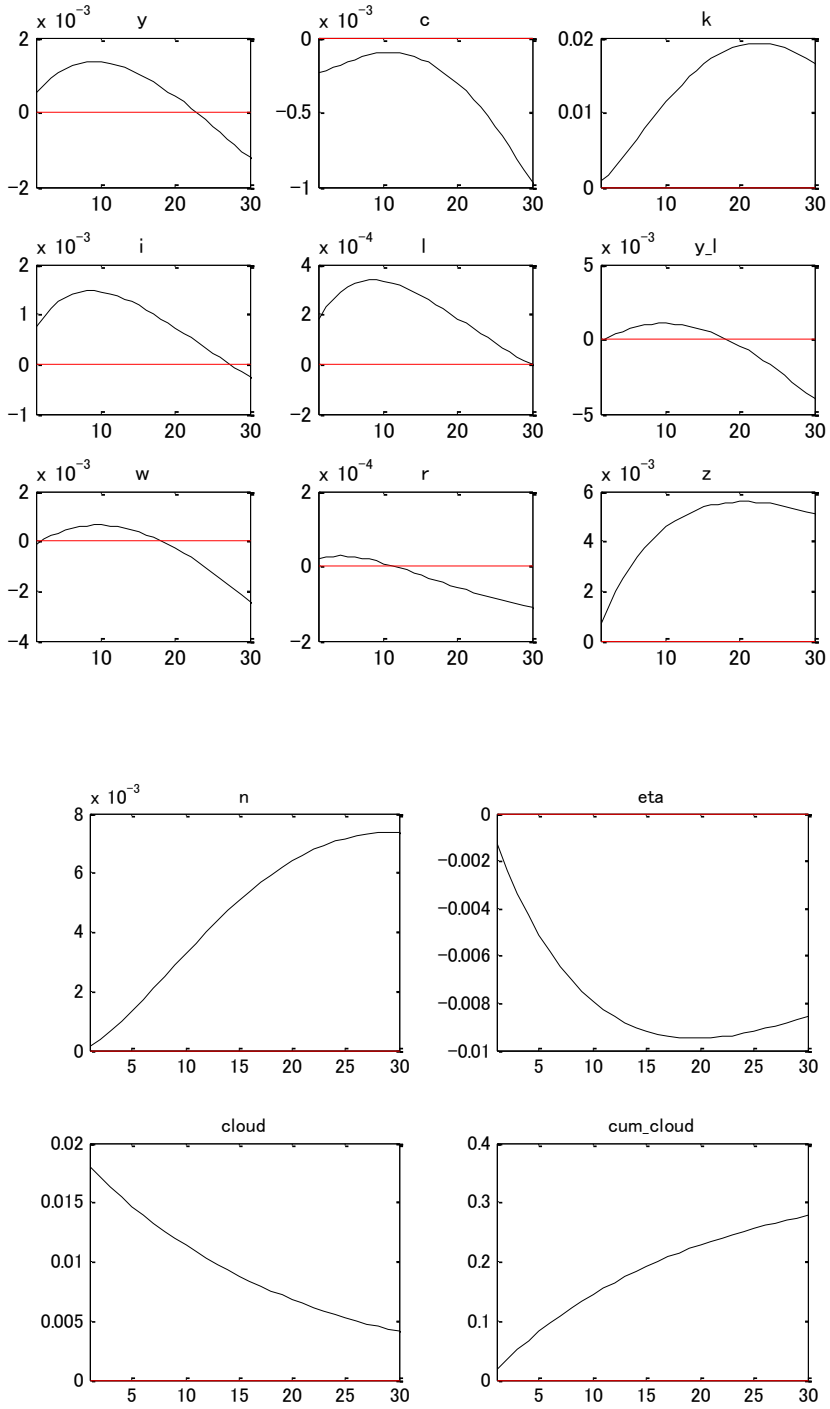




Appendix 6-D. Impulse response analysis (Scenario 4)



Appendix 6-E. Impulse response with ϕ = 0.04



Appendix 6-F. Steady state values

Endogenous variable	Steady state value
y	0.94456
c	0.74963
k	8.47499
i	0.19493
l	0.30273
y_l	3.12011
w	1.88142
r	0.03310
z	0.05716
n	1.03929
eta	0
cloud	0
cum_cloud	0

7. Discussion and Conclusion

7.1 Key Findings of the Analyses

This dissertation analyzed the impact of information technology on the economy, through structural change in productive organizations, following the stages from past to present. Chapter 3 discussed the underlying perception on organizational structure, specifically the mechanisms behind the firm's decision on the outsourcing of information services using transaction cost economics and service attributes. In particular, the discussion showed that the development of information technology affects service attributes such as heterogeneity and simultaneous production and consumption, which in turn affect transaction costs, such as opportunism and bounded rationality. Chapter 3 also provided the framework and the analytical tool to operationalize the theory to better understand a firm's choices of organizational structure. Discussion on organizational structure in Chapter 3 suggests that the development of IT affects the structure of productive organizations to a more decentralized and disintegrated form, through standardization and development of communication networks. Based on these arguments on organizational structure, quantitative analyses were conducted with the organizational change from past to present.

In the "past" stage, analyses on the impact of offshore outsourcing of information services in Chapters 4 and 5 showed that offshore outsourcing can generally raise productivity while reducing employment. From these analyses, it can be inferred that the outsourcing of high value-added services to high-cost countries can reduce employment while raising productivity, particularly on the manufacturing sector. On the other hand, the analyses revealed that the results are not uniform across trading partners. In particular, it was found that there are diverse effects depending on trading partners, even across Asian countries.

In the "present" stage, DSGE analysis on cloud computing in Chapter 6 suggested

that the key to achieving positive results from the utilization of cloud computing is productivity growth and a balance of international trade in computing services. However, as discussed in Chapter 6, a positive relationship between productivity and employment is not guaranteed. Particularly when demand is insufficient, a positive effect of productivity on employment is in question. As the discussion on organizational structure and transaction cost in Chapter 3 suggests, cloud computing can be easily outsourced even overseas because of the low transaction cost. Additionally, the outsourcing of computing resources are less visible to society than the outsourcing of traditional information services because it is the outsourcing of a common layer across multiple business functions rather than the outsourcing of a whole business unit such as call-center operation or software development. In this sense, the impact can become large and quick.

As discussed in Chapter 3, organizational changes whose impacts are analyzed in the preceding chapters can be explained by transaction cost economics, focusing on the decision whether or not the business should be conducted in-house or by third-party vendors. Regardless of buying or making, it is assumed that the business is conducted by organizations which contain a significant number of staff and resources. In other words, the previous chapters have dealt with the collaboration between organizations. On the other hand, collaboration between small units of production such as individuals was observed and also discussed in prior studies as one of the forms of production. These collaborations consist of small units of production, such as entrepreneurs, freelance workers, engineers, designers, and amateurs of them. These collaborations are still in an initial stage of emerging phenomena and not a major component of the economy. However, if this collaboration has an economic rationality as a productive organization, it can be viewed as one of the future developments of organizational structure.

In the First chapter, this study viewed the development of IT as affecting

organizational structure, and the change in organizational structure is continuously ongoing because of the ceaseless development of IT. Therefore, in order to draw implications from the results of the analyses, it would be worthwhile to explore the future development of organizational structure.

The next section addresses this point by discussing future organizational development. In particular, the latest development of mass collaboration is discussed as related to the open data movement and the shift to an information-centric economy. The next section also discusses how a future organization is economically rationalized and how it is related to outsourcings which are discussed in the previous chapters. The overall implications of this dissertation are discussed based on the results of analyses on offshore outsourcing and cloud computing and also the argument on future organizations.

7.2 Exploration of Future Organizational Structures

This section discusses mass collaboration. First, the development of mass collaboration is introduced based on prior studies. Second, the development of mass collaboration specifically in Japan is discussed in conjunction with the open data movement. Thirdly, the economic rationality of mass collaboration and its relation to outsourcings are discussed. Finally, implication of mass collaboration as a productive organization is analyzed in the general trend of the shift to an information-centric economy.

7.2.1 Development of mass collaboration

Tapscott and Williams (2006) focus on the trend in which IT enabled individuals to participate in economic activities, and calls it mass collaboration. The authors discuss mass collaboration as quite a broad term which includes various activities from the production based on a community of individuals and user’s involvement in design, to seeking solution

for society. Particularly in their illustration of peer production, Tapscott and Williams (2006) emphasize how work should be divided into small pieces so that individuals can participate. This idea is close to the other concept, crowdsourcing.

Crowdsourcing (Howe 2008) also focuses on the participation and collaboration of individuals, but suggests a more organized form of collaboration so that each individual can participate more easily in certain activities. Howe (2008) points out the importance of amateurs with the same level of knowledge as professionals, and opportunities to collect knowledge and the willingness of the amateurs to participate in the activity. At the same time, he suggests the importance of managing a community of participants, by keeping the unit of business assigned to each participant small. Whereas mass collaboration generally suggests the opportunity of participation and collaboration of individuals, crowdsourcing suggests a more specific form of collaboration focusing on amateur individuals and management by a community, which is designed for a certain purpose.

However, the definition of crowdsourcing is also a subject of discussion. Howe (2006) defines "crowdsourcing represents the act of a company or institution taking a function once performed by employees and outsourcing it to an undefined (and generally large) network of people in the form of an open call". Brabham (2012) defines crowdsourcing as "an online, distributed problem solving and production model whereby an organization leverages the collective intelligence of an online community for a specific purpose. It is a blend of traditional, top-down, hierarchical program management and bottom-up open innovation process" (p.395). However, there is a wide range of variation in the definition of crowdsourcing; therefore, building an integrated definition is one of the subjects of study (Estellés-Arolas and González-Ladrón-de-Guevara 2012).[1]

[1] Some prior studies discuss the risks and negative side of crowdsourcing. Frankrone (2013) poses risks for crowds who are underpaid in unsecured employment, and negative effects on traditional industry. Frankrone (2013) also points out the risk of harming a third party because of inaccuracy

The most cited cases of crowdsourcing are from Wikipedia (Estellés-Arolas and González-Ladrón-de-Guevara 2012) and Amazon Mechanical Turk (Hirth et al. 2012, Schall 2013, Estellés-Arolas and González-Ladrón-de-Guevara 2012, Lloret et al. 2012). Other examples of crowdsourcing are Threadless.com, iStockphoto.com, and InnoCentive.com, which are seen in Brabham (2012) and Estellés-Arolas and González-Ladrón-de-Guevara (2012). The Next Stop Design (Brabham 2012) and Goldcorp challenge (Marjanovic et al. 2012) also are included in crowdsourcing.

In a comparison of crowdsourcing and mass collaboration, the original meaning of mass collaboration suggested a general trend of collaboration of individuals, whereas crowdsourcing described a more specific form of collaboration which is characterized by a combination of top-down task design and bottom-up participation of a large number of people. However, as studies on mass collaboration gradually focused on peer production, the distinction of mass collaboration and crowdsourcing became vague.

As seen in prior studies, most examples of mass collaboration or crowdsourcing are initiatives based in North America as found in Wikipedia, Amazon Mechanical Turk, Threadless.com, iStockphoto.com, InnoCentive.com, The Next Stop Design, and Goldcorp challenge (Estellés-Arolas and González-Ladrón-de-Guevara 2012, Hirth et al. 2012, Schall 2013, Lloret et al. 2012, Brabham 2012, Marjanovic et al. 2012). On the other hand, Japan-based mass collaboration or crowdsourcing initiatives have not been well reported until recently. However, a new movement, open data, is stimulating the rise of mass collaboration in Japan. The next section discusses how open data is emerging and contributing to mass collaboration in Japan.

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and low quality brought out by crowdsourcing. Related to these points, Lloret et.al (2012) conducted an experiment regarding quality control for crowdsourcing.

7.2.2 Mass collaboration in Japan and the open data movement

In one definition, open data refers to "accessible public data that people, companies, and organizations can use to launch new ventures, analyze patterns and trends, make data-driven decisions, and solve complex problems" (Gurin 2014, 9). Generally, open data suggests a movement in which public organizations provide data which has been held by the organizations in a machine-readable format to the public, so that anyone can reuse the data (Takagi 2012a). According to the e-Government Open Data Strategy of Japan, the aims of open data are to (1) Enhance transparency and trust, (2) Promote citizen participation and public-private collaboration, and (3) Vitalize the economy and make public administration efficient (IT Strategic Headquarters 2012)[2]. The criteria as open data are different across countries. For example, The U.S. government provides seven principles of open data (OMB 2013). In Japan, the minimum criteria for open data are those provided by the Ministry of Internal Affairs and Communications (MIC)[3], which includes (1) provision of data in a machine-readable format and (2) data with rules allowing the reuse of the data.

Although open data is not necessarily limited to the data of public organizations, the open data movement has mainly evolved in the governmental sector (Takagi 2013). In order to promote open data, the U.S. government launched a portal website "Data.gov" in 2009, and the UK government also launched a similar portal website (Takagi 2012b). Data.gov.uk provides 17,786 datasets and shows 314 applications which are related to utilizing open data (as of December 2013). In Japan, the national government has started to provide data through Data.go.jp with 9,408 datasets in December 2013.

Although open data has various aims as stated earlier, the expectation of open data

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[2] Translation by the author.

[3] MIC. *Open data senryaku no suishin*. (in Japanese) http://www.soumu.go.jp/menu_seisaku/ictseisaku/ictriyou/opendata/index.html. (Accessed on April 6, 2014), Translation by the author.

as a new opportunity for innovation and economic growth has drawn much attention. For example, the French government expects that opening up public data can promote the information economy and innovation, and realize growth and employment[4]. The European commission issued an open data strategy for Europe in December 2011, expecting the economic impact of 40 billion Euros per year for the EU economy (European Commission 2011). Also in Japan, the expectation as an economic opportunity has become prominent[5].

Open data in Japan has advanced from local communities. "Where does my money go?" in a Japanese version[6], originated as an open source web service created by the Open Knowledge Foundation, a non-profit organization in UK, and is rapidly spreading to local communities in Japan. This service explains in a visual form on public spending so that citizens can comprehend the broad view on what amount of public money is spent on what sector. The Japanese version was initially created with data on Yokohama City in 2012, but it is spreading to local communities in Japan, reaching 130 regions as of April 2, 2014. One of the leading regions of open data in Japan is Sabae City in Fukui prefecture, which has published 40 datasets, which has in turn, created 36 applications and tools, as of April 6, 2014[7]. One example is the real-time location data for a community bus which is mapped in the Geographical Information System (GIS), so that residents can identify where the bus is running.

The most important effect of open data has been to make important data accessible for any entities, therefore, functioning as an opportunity and catalyst for many individuals to participate in productive activities. A number of events such as "hackathon"

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[4] Council of Ministers on August 31, 2011, http://www.etalab.gouv.fr/article-l-ouverture-des-donnees-publiques-a-l-ordre-du-jour-du-conseil-des-ministres-82988965.html.

[5] Details on the expectation on economic vitalization in Japan can be seen in a discussion form in the governmental committee, such as in http://www.kantei.go.jp/jp/singi/it2/densi/dai2/gijiyousi.pdf (in Japanese).

[6] The web service is available at http://spending.jp/.

[7] Sabae City. Data city Sabae. http://www.city.sabae.fukui.jp/pageview.html?id=11552, Accessed on April 6, 2014.

or “ideathon” have been organized around the world to explore the opportunity to utilize open data. Hackathon is a one or several days’ event through which engineers and designers gather and create new tools. Ideathon is a similar idea-generating event. Usually, the participants of these events are individual engineers. The “Where does my money go?” Japanese version has also been initially developed by engineers and consultants at one of these hackathons. “Application contests” are also gaining popularity in Japan. The processes of these types of events draw developers who create ideas or applications utilizing open data. Usually there are several months in the call for an application contest, and superior ideas and applications are awarded.

One of these events, International Open Data Day is organized by the Open Knowledge Foundation as an annual global event. In 2013, 8 Japanese communities participated among 102 communities worldwide[8], and in 2014, 32 Japanese communities participated among 111 communities worldwide[9]. Through these events, hundreds of citizens, engineers, consultants, and experts participated in producing value by using open data in Japan. These participants joined the events in each community trying to address various issues by sharing ideas and creating prototypes of solutions.

Open data is also related to the Civic Tech movement, which has emerged since the early 2010s. Civic tech is where civic engineers[10] participate in creating public value with skills on IT. The Knight Foundation (2013) provides an analysis of the types of businesses and funding for the civic tech organization, and places civic tech in the intersection of five related fields: collaborative consumption, crowd funding, social networks, community organizing, and government data. Because civic tech provides public value through IT skills, access to government data is one of the key resources of the

[8] http://wiki.opendataday.org/2013/City_Events, Accessed on May 31, 2014.
[9] http://wiki.opendataday.org/2014/City_Events, Accessed on May 31, 2014.
[10] In this section, the term “civic engineers” refers to people who have skills of IT and utilize these skills outside of their workplace, for public purposes based on their personal willingness.

activity.

A typical example of civic tech is *Code for America*[11], a nonprofit organization which hires highly skilled IT engineers and dispatches them to government organizations. More than 60 engineers are dispatched and more than 50 software applications have been developed in various regions (Code for America Website, as of January 2014). What makes *Code for America* new is that it is a network of engineers rather than a hierarchical organization, and it focuses on creating public value, rather than making profit from services. The experts who are dispatched to municipalities from *Code for America* are coders, engineers, and designers who are selected from applicants, and their task is not only to code new software, but also other diverse tasks such as discussions with citizens and public officials to find issues and solutions for a community (Walsh 2013). More than 600 experts applied in 2012, and they chose to participate in *Code for America* quitting a carrier in famous IT firms (Wakabayashi 2013).

In Japan, the affiliated organization *Code for Japan*[12] was launched in 2013. *Code for Japan* and its affiliated local groups in Japan invite various engineers and promote innovation by civic engineers. Another case of civic tech in Japan is seen in the Hack for Japan[13] project, which was started mainly by software engineers just after the Great East Japan Earthquake in March 2011 to help recovery efforts from disasters. Most engineers work for various IT-related firms, but they participate in activities as volunteers to utilize their skills and to support the affected regions.

As seen in this section, open data promotes the participation of individuals into activities such as organizing a community, finding issues, and creating solutions. Open data is not only for mass collaboration, but also for promoting various aspects such as

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[11] Its website is http://www.codeforamerica.org/
[12] Its website is http://code4japan.org/
[13] Its website is available at http://www.hack4.jp/.

government transparency, new business incubation, and addressing social issues. However in Japan, open data is functioning as an opportunity for participation and collaboration of individuals. Mass collaboration in Japan is still in its initial stage, but it is gradually becoming observable with the development of open data.

7.2.3 The economic rationality of mass collaboration

Chapters 3 to 6 discussed mainly outsourcing between organizations. How, then, is mass collaboration related to outsourcings, and how is it rationalized as an organizational form for producing value? Whereas Tapscott and Williams (2006) attribute the rise of mass collaboration simply to the reduction of transaction cost driven by the Internet, this section examines the rationality of mass collaboration as an organizational form by considering transaction cost as well as open data and the shift to an information-centric economy.

In Chapter 3 information technology is discussed as reducing service attributes and related transaction costs, thus promoting outsourcing. The first force to promote mass collaboration is further reduction of transaction costs, particularly in terms of the delivery of products and services. Small enterprises and individuals now can use cloud computing services with a significantly low cost to provide products and services such as smart phone applications to the global market. These platform services are designed to provide various functions such as showcase, payment, reputation management, and user engagement as cloud computing services. In most cases, the marginal cost of providing these electronic services to another consumer is low, therefore, these services are also relatively affordable for smaller business entities.

On the other hand, value which should be delivered is becoming more about handling information. Benkler (2006) suggests that while information and cultural production and the manipulation of symbols become the center of the economy,

communication networks have enabled non-market and decentralized production in information and cultural production. In the traditional manufacturing sector, various transaction costs such as the risk of inventory and logistics are taken into consideration and strict negotiation of specification is required in advance. However, in information production, the contents are delivered to a customer instantaneously through networks, and usually it is easy to modify the information after the delivery.

With the proliferation of service platforms and the shift to an information centric economy, transaction costs in terms of the delivery of value has been lowered. When transaction costs are high, the market can contain a limited number of players to a level in which negotiation on the transaction is economical. However, when transaction costs for delivery are lowered, the market can contain more players.

This increased number of players is also supported by standardization efforts. Baldwin and Clark (1997) argued that each supplier has freedom and flexibility designing the module as long as the module fits the *design rule*. Baldwin and Clark (1997) state that "this freedom to experiment with product design is what distinguishes modular supplier from ordinary subcontractors" (p.85). In other words, the standardization of modules and the participation of many suppliers have changed the relations of organizations from a command-and-control subcontractor style to collaboration of a larger number of independent entities.

However, the increase of entities in the market raises the transaction costs in terms of searching for the proper partner. Particularly in the information-producing business, finding the capability to create information with sufficient quality is required. However, it is not easy to search or identify those who have such a capability in advance from a vast number of players. The mediation by information technology such as InnoCentive[14] might

[14] Information about InnoCentive is available on their website at https://www.innocentive.com/.

have the effect of reducing costs for matching, but the difficulty of searching for sufficient capability on information production from an increased number of players would surpass the reduction of the search cost by mediation with information technology.

To this point, there is the benefit of a bottom-up and collaborative style of production. Tapscott and Williams (2006, p.69) point out, “When people voluntarily self-select for creative, knowledge-intensive tasks they are more likely than managers to choose tasks for which they are uniquely qualified”. In other words, there is a benefit in leaving the decision to participate in the activity for each player, rather than dispatching the job in a command-and-control organization, because each player knows best about their own capabilities. Garicano and Van Zandt (2013) explain the historical debate on information constraints and states that information-processing constraints leads to decentralized decision making based on different information. Bottom-up decision making in mass collaboration is rationalized from the information constraint on the capability on information production.

The argument in this section is summarized in Figure 7-1. In sum, technological innovation and a shift to an information-centric economy reduces transaction costs for delivery and increases the number of players in market. However, as the contents of business become more about information and knowledge, it becomes difficult to organize command-and-control style outsourcings. Instead, the autonomic participation of providers better mediates the resource allocation particularly in terms of the capability of the players. This autonomy and participation characterize mass collaboration.

A description of the company is available at Brabham (2012) and Estellés-Arolas and González-Ladrón-de-Guevara (2012).

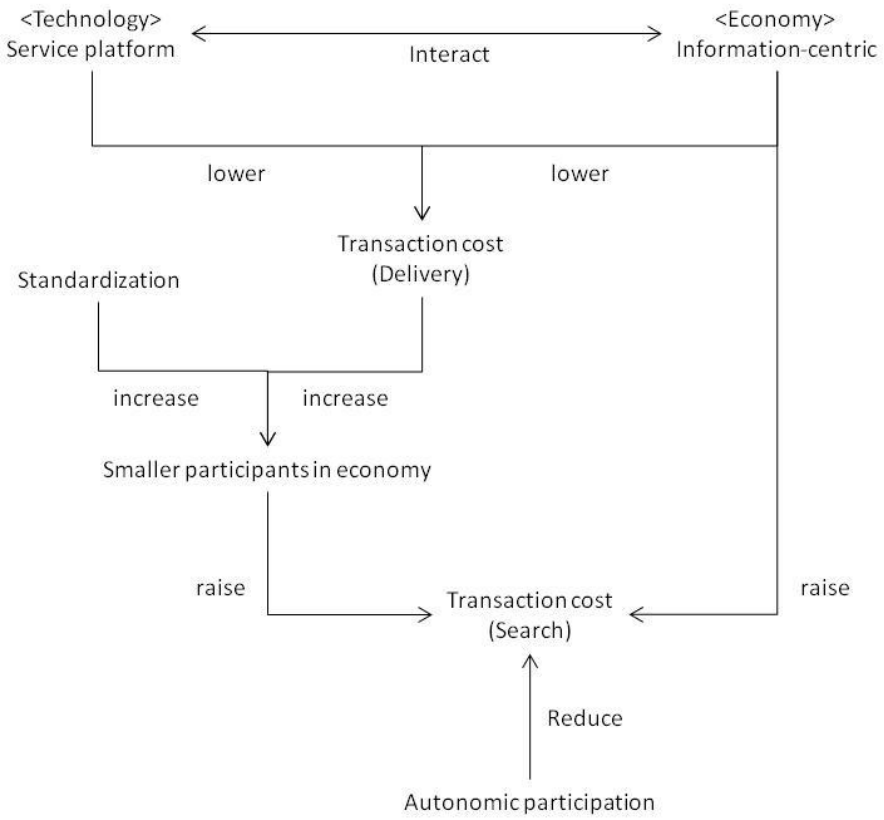

Figure 7-1. The economic rationality of mass collaboration

Chapter 3 discussed how standardization reduced the risk of opportunism, and communication networks reduced the risk of uncertainty, thus promoting outsourcing. However, when the economy becomes more about information production, and this information production requires unique knowledge or skills, mass collaboration is more rationalized than organization-to-organization outsourcing.

7.2.4 Production in an information economy

Then, how does the rise of mass collaboration have the impact on the economy, particularly from a macroeconomic perspective? First, as more small entities participate in collaboration globally, it becomes difficult to capture the impact of the collaboration on the

national economy. When collaboration takes the form of organization-to-organization outsourcing, the impact on the economy is more direct because organizations hire a significant number of employees, and relations of output, employment, and income are clear. On the other hand, the activities of smaller entities such as individuals are as diverse as selling smart phone applications to nonmonetary activities such as editing Wikipedia. As the collaboration takes on a more complicated web of production, it becomes difficult to capture its impact on the economy, particularly when this collaboration is about information production.

Secondly, the relationship between output, value, and income becomes indirect in mass collaboration particularly when it is about information production. In the traditional economy, the relationship between output, value, and income are directly related to each other, as shown in panel (A) in Figure 7-2. This is because the decisions in conducting the business of organizations are based on the judgment of profit or return on investment. However, the relationship between output, value, and income is not so direct in mass collaboration particularly for information production, as shown in panel (B) in Figure 7-2. For example, the creation of one page in Wikipedia (output) might have a quite small value, but the value becomes enormous when thousands of pages are combined. The writer of the page might not have any income from editing the page, but the experience of editing Wikipedia may help him or her to acquire knowledge about the topic and to get a large contract from third parties based on the experience.

(A) (B)

Figure 7-2. Relationship between Output, Value, and Income

Indirect relation of output, value and income has also been related to the intrinsic nature of information. Noguchi (1974) pointed out that the value of information can be measured by the reduction of uncertainty, but this value is not related to the quantity of information,[15] and moreover, the value and price of information is a different concept, because the value is determined by the demand side whereas the price is determined by the combination of demand and supply. On the other hand, Bressand (1991) also suggested that the value of information has to be realized by the cooperation of a producer and consumer, and the price of information is attached to the relationship between them, rather than the object of trade. In either case, the value of information cannot be measured or realized without depending on a certain customer.

The recent development of business in information services shows such an indirect relation of output, value, and income. For example, contents in Facebook are created by 1.11 billion users, and the firm value of Facebook surpassed 100 billion U.S.

[15] He suggests that program information can be assessed as productivity, and information for consumption can be assessed as certain units of quantity such as time, number of letters.

dollars (Womack 2013). In this case, the collective value of information is accumulated at a point which manages the information flow, but each content which is created by users is not necessarily priced. This gap between the value of each content and the collective value is one of the examples that shows the complexity of the relation between output and value in modern information services. Mass collaboration is still not the major component of the economy. However, traditional approaches of economics focusing on output and productivity may face questions when the economy is more information-centered, and the relation between output, value, and income becomes more indirect.

This section discussed the “future” stage of the framework presented in Chapter 1, by discussing mass collaboration based on the description of the latest practices and the qualitative argument. While previous chapters focused on outsourcing relations between organizations, this section discussed how the development of IT has enabled not only collaboration between organizations, but also between individuals. Mass collaboration is still in its initial stages particularly in Japan, and it is still not clear if it will become one of the major forms of production. However, as seen in this section, mass collaboration and outsourcing partly share common grounds in terms of the development of IT and transaction costs. As discussed in Chapter 1, organizational structure is continuously affected by the development of IT. Therefore, it is worthwhile to take into account the future development of organizational structure to discuss the implications from analyses in Chapter 3 to 6. The next section integrates the results of analyses on offshore outsourcing and cloud computing in previous chapters and also the argument on mass collaboration, to discuss overall implications throughout the dissertation.

7.3 Overall Implications

As discussed in Chapter 1, this research has advanced the discussion along with the

timeline and technological development, in order to provide an integrated view on the economic impact of organizational changes which are brought about by the development of information technology. Based on the argument in Chapter 3 about how information technology has affected organizational structure, the economic impacts of offshore outsourcing of information services are assessed in Chapters 4 and 5. On the other hand, Chapter 6 analyzed the economic impact of cloud computing. In addition, the previous section in this chapter has discussed mass collaboration, combined with the latest movement of open data and the shift to an information-centric economy.

Each analysis has complex findings which are discussed in each chapter. This section integrates these findings and draws key implications which are obtained throughout the analyses based on the integrated approach of this research. The key implications are summarized into three points as follows.

Organizations are changing to a vertically disintegrated form by the development of IT

As seen in Chapter 3, the development of information technology reduces service attributes such as heterogeneity and simultaneous production and the consumption of information services. This reduction of service attributes lowers a part of transaction costs, such as the risk of opportunism and uncertainty. In particular, the development of communication networks and tools has played an important role in reducing uncertainty when the services are conducted in distant locations, and the standardization of services associated with the development of tools including CRM reduced the risk of opportunism. Cloud computing is an advanced form of taking advantages of standardization and improved communication networks.

These technological developments are also the results of social and business demand. Offshore outsourcing of information services is driven by the demand of

businesses that try to benefit from a difference in factor prices, such as wages, land, and energy. On the other hand, cloud computing is promoted by the expectation on the scale economy of computing services, by both providers and customers. In this context, technological development has realized the feasibility of meeting these business demands on economy of scale. As a result, hierarchical, vertically integrated organizations are able to separate certain information services and outsource them to third party vendors. In the last decade, this took the form of offshore outsourcing and cloud computing suggesting the trend to vertical disintegration of organizations.

With the rise of the possibility to standardize business processes, outsourced information services are facing an opportunity to be accumulated globally to enjoy the merits of the scale economy by serving more customers worldwide. This is particularly observed in the form of cloud computing, and suggests the trend to horizontal accumulation. Therefore, the impact of IT suggests a trend in the rearrangement of business functions along with the direction to vertical disintegration, and possibly horizontal accumulation.

However, the trend of mass collaboration suggests that there is an area in which it is difficult to benefit from the scale economy. This is because of the heterogeneous nature of the contents of the information and required activities, from finding the issues in a community to creating tailor-made applications. In a sense, mass collaboration fills in the area which needs variety in knowledge and information, and cannot be addressed by organizations which aim at a scale economy.

How to overcome downward pressure on employment is the key to benefiting from IT

The assessment on the impact of offshore outsourcing on the economy in Chapters 4 and 5 suggested that downward pressure on employment is generally prominent in Japan.

Particularly, these analyses showed that the impact of offshore outsourcing is on the rise in productivity and in the reduction of employment. On the other hand, DSGE analysis on cloud computing in Chapter 6 suggested that it is also possible to raise output and employment, if productivity growth is sufficient.

However, as discussed in Chapter 6, one of the reasons for the positive relation between productivity and employment in DSGE analysis may be the unconstrained demand. In this sense, in order to realize the benefit of IT on the economy, it is important to ensure that IT contributes to the development of new products or services which create new demand.

Additionally, this research assumes that organizational changes evolve along a timeline, but this evolution does not necessarily mean these organizations shift one after another exclusively. Instead, these new organizational forms can evolve and overlap each other, therefore, offshore outsourcing and cloud computing can be utilized simultaneously. Additionally, as discussed in Chapter 1, the evolution of organizational structure can accelerate with the accumulation of available technologies. In this sense, the impact of IT on the economy depends on how comprehensively the results are taken into consideration. From the analyses in this dissertation, it is inferred that IT contributes to productivity growth through offshore outsourcing, but is not sufficient to support the growth of the whole economy. Instead, ensuring that information technology creates new demand is important in making the economy sustainable, particularly in terms of employment.

There are significant differences among Asian countries as trading partners.

One of the other findings in this research is that the effect of offshore outsourcing on the economy depends on trading partners, even within Asian countries. In terms of the effect on employment in the lagged model in Chapter 4, only outsourcing to China has a positive

effect on manufacturing employment, whereas outsourcing to India and the ASEAN6 countries has negative effects. In terms of the effect on productivity in the lagged model in Chapter 5, outsourcing to China has a positive effect, whereas outsourcing to ASEAN6 countries has a negative effect.

The most highlighted result is the uniqueness of China as a trading partner of Japan. Outsourcing to China has a positive effect both on employment and productivity in the lagged model. As introduced in Chapter 4, China has the unique characteristic of lingual proximity with Japan. There has also been an established relation between China and Japan as trading partners[16]. The lingual proximity and experience as trading partners would have contributed to achieving the positive effects from information services outsourcing to China[17].

In the argument about economic integration in Asia, Fujita (2007b, p.5), for example, discussed that the intra-trade share of East Asia[18] has been increasing rapidly, from 34.9% in 1980 to 52.4% in 2003. These arguments on economic integration emphasize the interdependency of the economy in certain regions across countries. However, this dissertation showed that there is significant diversity in the effects of international trade of information services on the national economy depending on trading partners. In this sense, it is important to consider how to realize mutually-beneficial relationships with each country, instead of generalizing Asia as a trading partner.

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[16] Fujita (2007a) suggests that China was the second largest export-partner and the top import-partner of Japan in 2004.

[17] In addition, Takagi (2011) shows that cultural characteristics are important factors in drawing foreign direct investment into the service sector. Takagi (2011) does not discuss the proximity between trading partners, but suggests the importance of intangible factors such as culture and language in the service sector.

[18] East Asia in this analysis in Fujita (2007b) consists of the ASEAN10, China, Japan, Hong Kong, South Korea, and Taiwan.

7.4 Academic Contributions

Each analysis in this dissertation filled in the missing points in prior studies which are discussed in Chapter 2. Prior studies on information technology and economy mainly assess the direct relations between information technology and productivity as discussed in Chapter 2. This study tries to assess the impact of information technology through organizational changes, and analyses in each chapter have provided building blocks in the field of analyzing the relation between information technology and economy. In addition to filling in missing points in prior studies, academic contribution of this dissertation is summarized into the following points.

At first, this dissertation found the statistical evidences on the impact of offshore outsourcing of information services from Japan specifying trading partners. Particularly, it found the variety in the effects of offshore outsourcing even limited to Asian countries. These results suggest the importance of examining the effects of trade with Asian countries in detail, rather than generalizing Asia as a trading partner.

Second, this dissertation has advanced a way to use DSGE approach flexibly to a wider range of topics including the impact of information technology. Compared to prior studies, this study provided a more flexible and comprehensive model to analyze technological development and its impact on economic variables. On the other hand, the argument in the final chapter suggested the challenges of the traditional approach of economic analyses including DSGE approach, when the economy consists more of activities on information production.

Each chapter provides new findings and discussions on each topic, and this dissertation as a the whole has integrated the discussions on each topic to draw implications on the impact of information technology on the economy through organizational changes. In particular, this dissertation integrated multiple organizational

changes in an evolutionary path, which is explained by transaction cost economics, and has drawn implications from the results of the analyses. This dissertation also showed a way to assess the economic impact of information technology through the organizational changes, integrating macro and microeconomic approach. This integrated approach is also the contribution of this dissertation.

7.5 Limits and Future Challenges

There are limitations in each analysis such as measurement, data availability, and the development of an economic model. Detailed explanation on the limitations on each analysis has been provided at the end of each chapter. Addressing these limitations is one of the future challenges of this research. Besides them, there are following directions for future challenges.

The first challenge for the future regards the geographic aspects in the age of networked production. As discussed in this chapter, the web of production which consists of individuals around the world is becoming observable. On the other hand, a geographical perspective is still important, in terms of infrastructures, environment, quality of life, and availability of products and services that have a significant variety. These factors are also important for creative work such as discussed by Florida (2007). Therefore, a future challenge is to build a general theory on the geographical aspects of a production network, applicable in the age of network and mass collaboration. This challenge should include a discussion on the capability of creative works and their agglomeration, the relation of a community to global production networks, and the changes in the locational constraints in productive activities in a global production network.

The second challenge for future research is how to incorporate the value of information in current economic frameworks such as in production functions. Noguchi

(1977, p.48) suggests that it is almost impossible to find a quantitative relation between input and output for producing information such as knowledge. On the other hand, as discussed in this chapter, the value of information might be accumulated somewhere instead of the site of production. This difficulty in capturing the value of information suggests other challenges for the current economic framework.

The third challenge for the future as discussed specifically in Chapter 3, is quantifying the impact of IT on organizational structure. There are several studies that quantify the relation of IT and organizations (e.g. Hitt and Brynjolfsson 1997, Brynjolfsson et al. 1994). However, along with the topics of this dissertation, it is also one of the options to measure the transaction costs in information services and analyze how much these costs are reduced by the development of IT. This approach of quantifying the transaction costs also includes identifying the threshold of transaction costs by which firms decide to outsource the business process to outside entities within or outside of a country.

Rapid development of IT is still ongoing and its effect on society is also continuing. The central issue in future challenges arises in the balance between the inclusion of the latest developments and building a general theory which can be applied through a wide variation of phenomena.

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